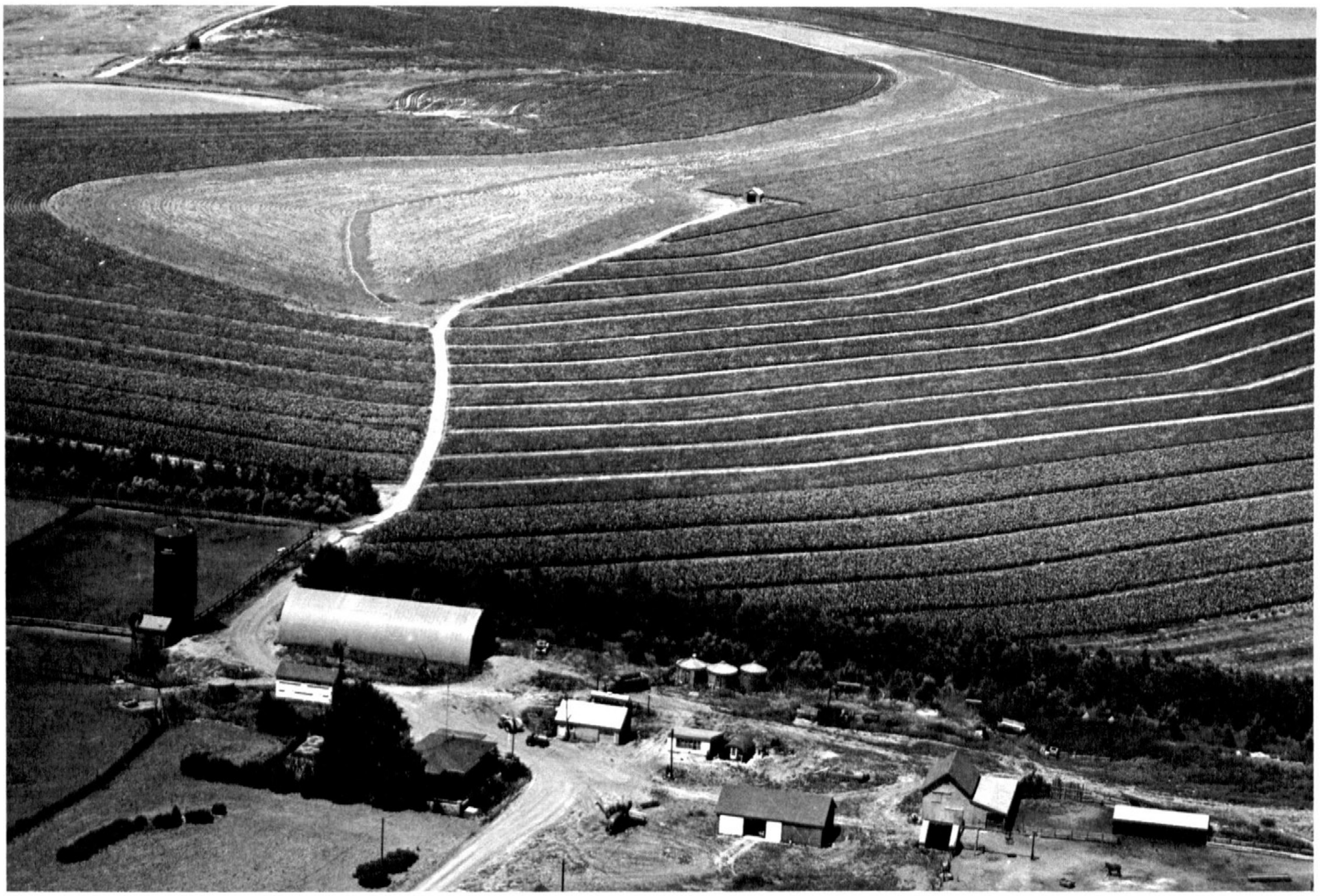
Issued April 1967

Soil Survey

RED WILLOW COUNTY NEBRASKA



UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
In cooperation with
UNIVERSITY OF NEBRASKA
Conservation and Survey Division

Major fieldwork for this soil survey was done in the period 1958–1960. Soil names and descriptions were approved in 1965. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1960. This survey was made cooperatively by the Soil Conservation Service and the University of Nebraska Conservation and Survey Division; it is part of the technical assistance furnished to the Red Willow County Soil Conservation District.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY of Red Willow County contains information that can be applied in managing farms, ranches, and woodland; in selecting sites for roads, ponds, buildings, or other structures; and in appraising the value of tracts of land for agriculture, industry, or recreation.

Locating Soils

All the soils of Red Willow County are shown on the detailed map at the back of this report. This map consists of many sheets that are made from aerial photographs. Each sheet is numbered to correspond with numbers shown on the Index to Map Sheets.

On each sheet of the detailed map, soil areas are outlined and are identified by symbol. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

Finding and Using Information

The "Guide to Mapping Units" can be used to find information in the report. This guide lists all of the soils of the county in alphabetic order by map symbol. It shows the page where each kind of soil is described, and also the page for the dryland and irrigated capability units and the range sites.

Individual colored maps showing the relative suitability or limitations of soils for many specific purposes can be developed by using the soil map and information in the text. Interpretations not included in the text can be developed by grouping the soils according to their suitability or limitations for a particular use. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

Farmers and those who work with farmers can learn about use and management of the soils in the section that describes the soils and in the section that discusses management of the soils for cultivated crops and for rangeland.

Foresters and others can refer to the section "Woodland and Windbreaks," where the soils of the county are grouped according to their suitability for trees and windbreaks.

Game managers, sportsmen, and others concerned with wildlife will find information about soils and wildlife in the section "Managing Wildlife."

Ranchers and others interested in range can find, under "Managing Rangeland," groupings of the soils according to their suitability for range, and also the plants that grow on each range site.

Engineers and builders will find under "Engineering Properties of the Soils" tables that give engineering descriptions of the soils in the county and that name soil features that affect engineering practices and structures.

Scientists and others can read about how the soils were formed and how they are classified in the section "Formation, Classification, and Morphology of Soils."

Students, teachers, and others will find information about soils and their management in various parts of the text, depending on their particular interest.

Newcomers in Red Willow County may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the section "General Nature of the County," which gives additional information about the county.

Cover picture: **Contour bench irrigation on Holdrege and Keith silt loams in Red Willow County.**
(Courtesy of Richard Hufnagle, the photographer.)

U.S. GOVERNMENT PRINTING OFFICE: 1967

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402

Contents

NOTICE TO LIBRARIANS

Series year and series number are no longer shown on soil surveys. See explanation on the next page.

Issued______________April 1967

EXPLANATION

Series Year and Series Number

Series year and number were dropped from all soil surveys sent to the printer after December 31, 1965. Many surveys, however, were then at such advanced stage of printing that it was not feasible to remove series year and number. Consequently, the last issues bearing series year and number will be as follows:

- Series 1957, No. 23, Las Vegas and Eldorado Valleys Area, Nev.
- Series 1958, No. 34, Grand Traverse County, Mich.
- Series 1959, No. 42, Judith Basin Area, Mont.
- Series 1960, No. 31, Elbert County, Colo. (Eastern Part)
- Series 1961, No. 42, Camden County, N.J.
- Series 1962, No. 13, Chicot County, Ark.
- Series 1963, No. 1, Tippah County, Miss.

Series numbers will be consecutive in each series year, up to and including the numbers shown in the foregoing list. The soil survey for Tippah County, Miss., will be the last to have a series year and series number.

SOIL SURVEY OF RED WILLOW COUNTY, NEBRASKA

BY NORMAN W. HUBER, RONALD R. HOPPES, NORMAN L. SLAMA, AND MAX A. SHERWOOD, SOIL CONSERVATION SERVICE

UNITED STATES DEPARTMENT OF AGRICULTURE IN COOPERATION WITH THE UNIVERSITY OF NEBRASKA, CONSERVATION AND SURVEY DIVISION

RED WILLOW COUNTY is in southwestern Nebraska, and Kansas forms its southern boundary. The total land area is 458,240 acres, or 716 square miles. The location of Red Willow County in Nebraska is shown in figure 1.

The general slope of the county is eastward, and the average elevation is 2,600 feet above sea level. McCook, the county seat, which is located on U.S. Highways Nos. 6, 34, and 83, has an elevation of 2,565 feet. The Republican River and Red Willow and Beaver Creeks are the main streams that flow through the county.

Agriculture is the principal enterprise. Wheat, corn, and grain sorghum are the main crops grown under dryland and irrigated farming, but alfalfa, field beans, safflower, and potatoes are also grown. Wheat is the main cash crop.

More than one-third of the county is in native grass used for range, and most of the range is used for production of beef cattle. A large part of the forage and grain crops grown in the county is fed to livestock.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soils are in Red Willow County, where they are located, and how they can be used.

They went into the county knowing they likely would find many soils they had already seen, and perhaps some they had not. As they traveled over the county, they observed steepness, length, and shape of slopes; size and speed of streams; kinds of native plants or crops; kinds of rock; and many facts about the soils. They dug or bored many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by roots of plants.

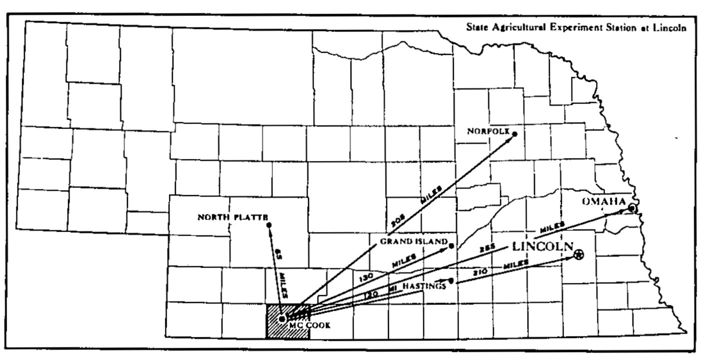


Figure 1.—Location of Red Willow County in Nebraska.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. For successful use of this report, it is necessary to know the kinds of groupings most used in a local soil classification.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Colby and Holdrege, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that go with their behavior in the natural landscape. Soils of one series can differ in texture of the surface soil and in slope, stoniness, or some other characteristic that affects use of the soils by man.

Many soil series contain soils that differ in texture of their surface layer. According to such differences in texture, separations called soil types are made. Within a series, all the soils having a surface layer of the same texture belong to one soil type. Bankard fine sand and Bankard loamy fine sand are two soil types in the Bankard series. The difference in texture of their surface layers is apparent from their names.

Some types vary so much in slope, degree of erosion, number and size of stones, or some other feature affecting their use, that practical suggestions about their management could not be made if they were shown on the soil map as one unit. Such soil types are divided into phases. The name of a soil phase indicates a feature that affects management. For example, Bridgeport silt loam, 1 to 3 percent slopes, is one of three phases of Bridgeport silt loam, a soil type that ranges from nearly level to gently sloping.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These

photographs show woodlands, buildings, field borders, trees, and other details that greatly help in drawing boundaries accurately. The soil map at the back of this report was prepared from the aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning management of farms and fields, a mapping unit is nearly equivalent to a soil type or a phase of a soil type. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some other kind that have been seen within an area that is dominantly of a recognized soil type or soil phase.

In preparing some detailed maps, the soil scientists have a problem of delineating areas where different kinds of soils are so intricately mixed, and so small in size, that it is not practical to show them separately on the map. Therefore, they show this mixture of soils as one mapping unit and call it a soil complex. Ordinarily, a soil complex is named for the major kinds of soils in it; for example, Hord-slickspot complex. The soil scientist may also show as one mapping unit two or more soils that have differences not significant enough to make it practical to show them separately on the map. Such a mapping unit is called an undifferentiated soil group. An example is Holdrege and Keith silt loams, 3 to 6 percent slopes. Also, on most soil maps, areas are shown that are so rocky, so shallow, or so frequently worked by wind and water that they scarcely can be called soils. These areas are shown on a soil map like other mapping units, but they are given descriptive names, such as Broken alluvial land, and are called land types rather than soils.

While a soil survey is in progress, samples of soils are taken, as needed, for laboratory measurements and for engineering tests. Laboratory data from the same kinds of soils in other places are assembled. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soils. Yields under defined management are estimated for all the soils.

But only part of a soil survey is done when the soils have been named, described, and delineated on the map, and the laboratory data and yield data have been assembled. The mass of detailed information then needs to be organized in a way that it is readily useful to different groups of readers, among them farmers, ranchers, managers of woodland, engineers, and homeowners. Grouping soils that are similar in suitability for each specified use is the method of organization commonly used in the soil survey reports. The soil scientists set up trial groups, based on the yield and practice tables and other data, and test them by further study and by consultation with farmers, agronomists, engineers, and others. Then the scientists adjust the groups according to the results of their studies and consultation. Thus the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under present methods of use and management.

General Soil Map

The general soil map at the back of this report shows, in color, the soil associations in Red Willow County. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

A map showing soil associations is useful to people who want a general idea of the soils in a county, who want to compare different parts of a county, or who want to know the location of large tracts that are suitable for a certain kind of farming or other land use. Such a map is not suitable for planning the management of a farm or field, because the soils in any one association ordinarily differ in slope, depth, drainage, and other characteristics that affect management.

There are four soil associations in Red Willow County. Almost half of the county consists of moderately sloping loess plains in the uplands and of sloping to steep canyons. The rest consists of loamy soils on stream terraces, bottom lands, and foot slopes in the uplands, of sandy and loamy soils along the Republican River, and of silty soils on steep loess hills and in canyons.

1. Holdrege-Keith Association

Silty soils on nearly level to moderately sloping loess uplands and in sloping to steep canyons

The soils in this association are on nearly level to moderately sloping loess plains in the uplands and in sloping to steep canyons. The area of this association is 263,600 acres, or about 58 percent of the county. Holdrege and Keith soils make up 75 percent of the association, and Ulysses soils, 12 percent. Colby and Hord soils make up the rest of the association.

Holdrege and Keith soils are deep, silty soils on nearly level and gently sloping loess plains (fig. 2). The most extensive areas of Holdrege soils are in the eastern part of the county, but Keith soils are mostly in the western part. Both the Holdrege and Keith soils have a surface layer of dark silt loam 6 to 16 inches thick. Holdrege soils have a subsoil that is slightly finer textured than that of the Keith soils, and their profile has more distinct structure. The substratum of both soils is light-colored, silty material that contains lime.

The Ulysses soils are mostly in moderately sloping areas in the loess uplands. Their profile is intermediate in development between that of the Holdrege and Keith soils and that of the Colby soils. Lime is at a depth of 5 to 15 inches in areas of Ulysses soils under native grass, but it is at or near the surface in cultivated areas, because erosion has removed material from the surface soil.

Colby soils are deep and silty and are in sloping to steep canyons. Their surface layer is thin, slightly darkened material, and their substratum is light-colored, silty material that contains lime. Colby soils are generally used for pasture, but a few small areas are cultivated.

Hord soils are in nearly level and concave areas in the uplands, and they receive extra moisture because of runoff from surrounding areas. These soils have a thicker and darker colored profile than that of the Holdrege soils, and they contain layers made up of old buried soils.

The Holdrege, Keith, and Hord soils and some areas of the Ulysses and Colby soils are cultivated, but the rest of the soils in this association are pastured. Cultivated areas are used for wheat, grain sorghum, and corn. Forage sorghum is grown for feed on livestock farms.

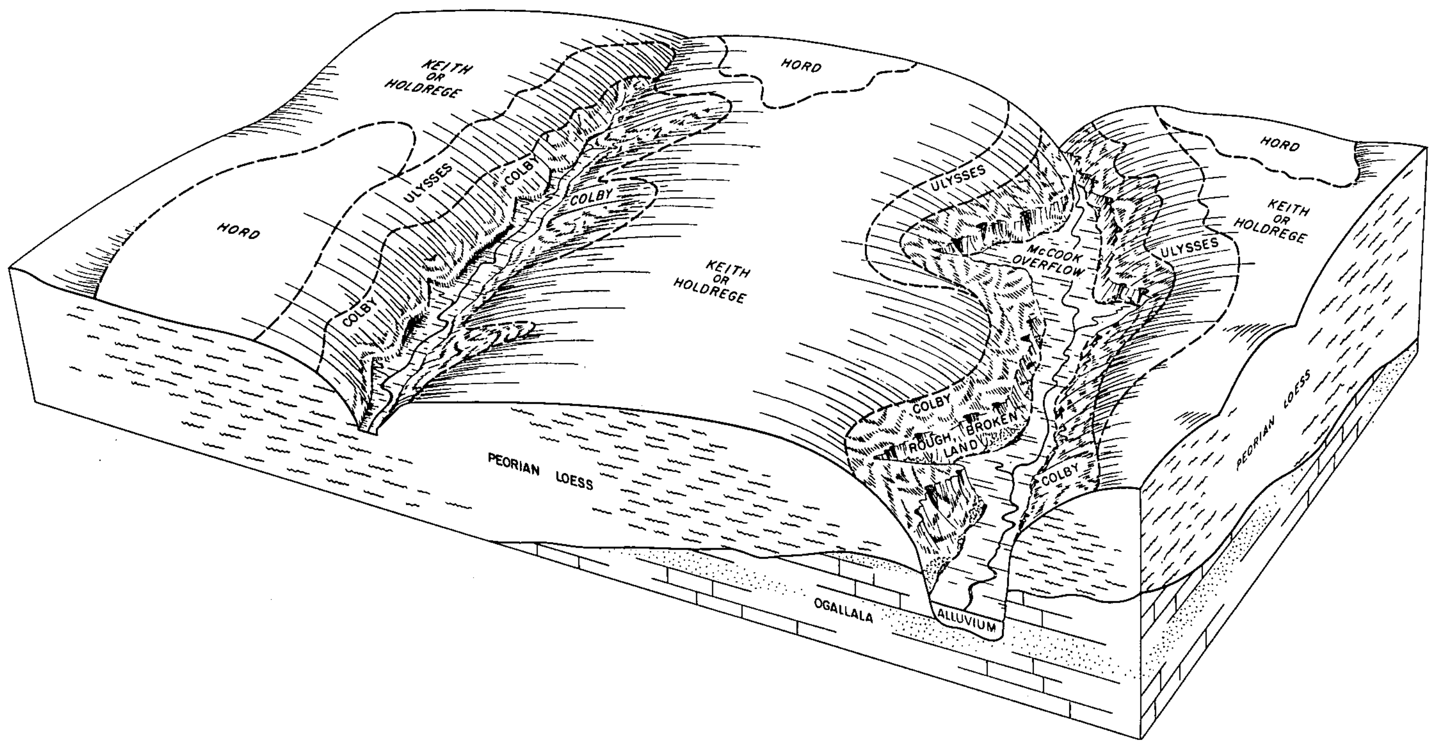


***Figure 2.*—Typical pattern of soils in the Holdrege-Keith association.**

The main problems are controlling wind and water erosion, conserving moisture, and maintaining a balance between the supply of plant nutrients and the supply of moisture.

2. Hord, Terrace-McCook-Bridgeport Association

Loamy soils on stream terraces, bottom lands, and foot slopes

The soils in this association are on nearly level to gently sloping stream terraces, bottom lands, and foot slopes. There are 56,050 acres in this association, or more than 12 percent of the county. Hord, terrace, soils occupy 39 percent of the association; McCook soils, 36 percent; and Bridgeport soils, 22 percent. The rest consists of small areas of Haverson, Glenberg, and Bayard soils.

Hord, terrace, soils are on nearly level to very gently sloping stream terraces along the Republican River, Beaver Creek, and the main tributaries of those streams (fig. 3). They are deep, silty soils, and they formed in alluvium that contains lime.

McCook soils, on nearly level bottom lands of streams, are deep and silty, and are moderately dark and limy. Areas of these soils along Beaver and Red Willow Creeks are flooded after heavy rains by overflow from the streams.

Bridgeport soils are on nearly level to gently sloping colluvial fans and foot slopes in the uplands. These soils are deep, moderately dark, and silty. They have weakly defined layers and are calcareous from the surface into the substratum.

The silty Haverson soils and the moderately sandy Glenberg soils are on bottom lands. The moderately sandy Bayard soils are on colluvial slopes.

The soils in this association are well suited to irrigation, and most areas are irrigated. Corn, grain sorghum, and alfalfa are the main crops grown.

The main problems on the more sandy soils are maintaining fertility and controlling erosion. Land leveling is needed in most irrigated areas before water can be distributed properly.

3. Sandy Alluvial Land-Las-Glenberg Association

Sandy and loamy soils on lowlands along the Republican River

The soils in this association are on the low flood plains along the Republican River (fig. 4). The total area is 13,590 acres, or about 3 percent of the county. Sandy alluvial land makes up about 32 percent of the association, Las soils 19 percent of the association, and Glenberg soils 17 percent. The rest of the association is made up of Bankard and Barney soils. All of these soils are subject to overflow from the river. The areas are nearly level to gently undulating and consist of material laid down by floodwaters. The water table is at a depth of 1 to 6 feet.

Sandy alluvial land consists mostly of very sandy material, but some layers range from silty clay loam to sand and gravel. Las soils consist of light-colored, loamy material that is covered by sand and contains variable amounts of salts or alkali. Glenberg fine sandy loam, slightly wet, is moderately sandy. In this soil, depth to the water table ranges from 2 to 6 feet. The very sandy

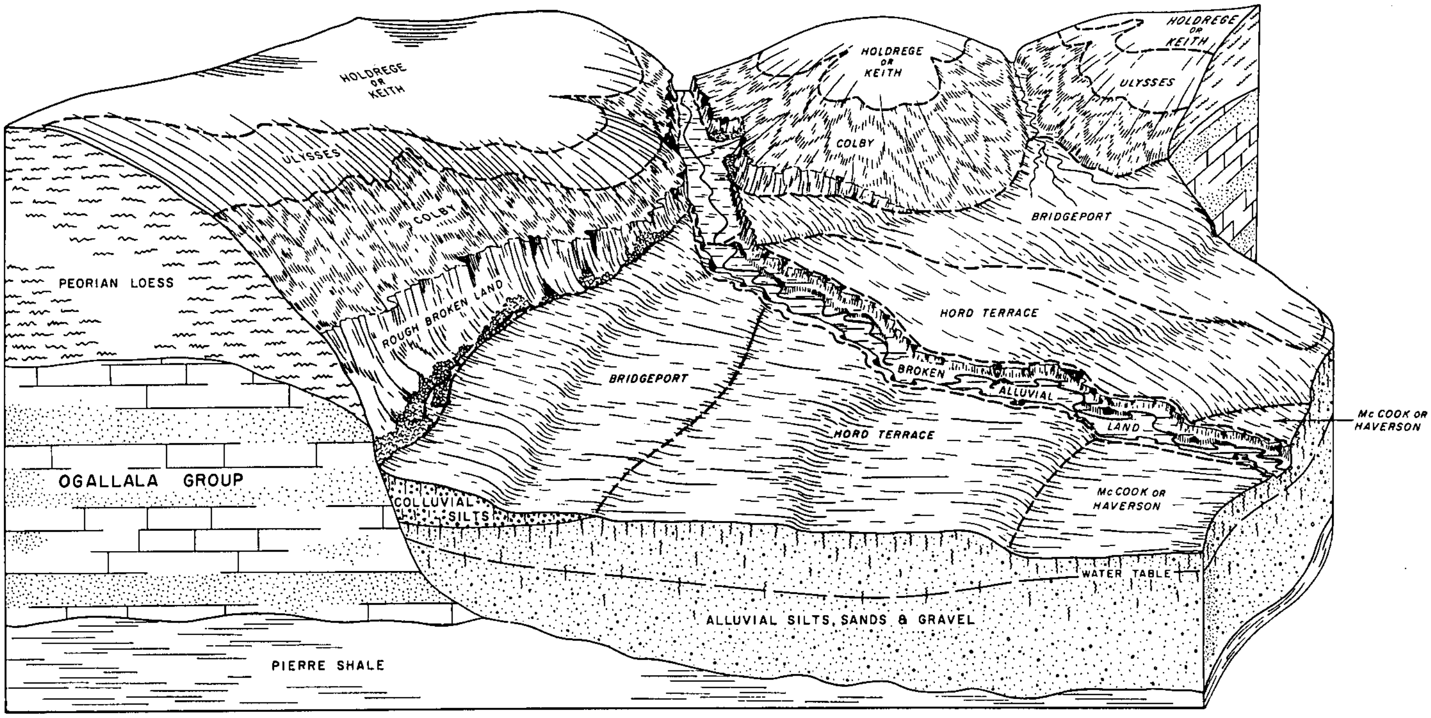


Figure 3.—**Typical pattern of soils in the Hord, terrace-McCook-Bridgeport association.**

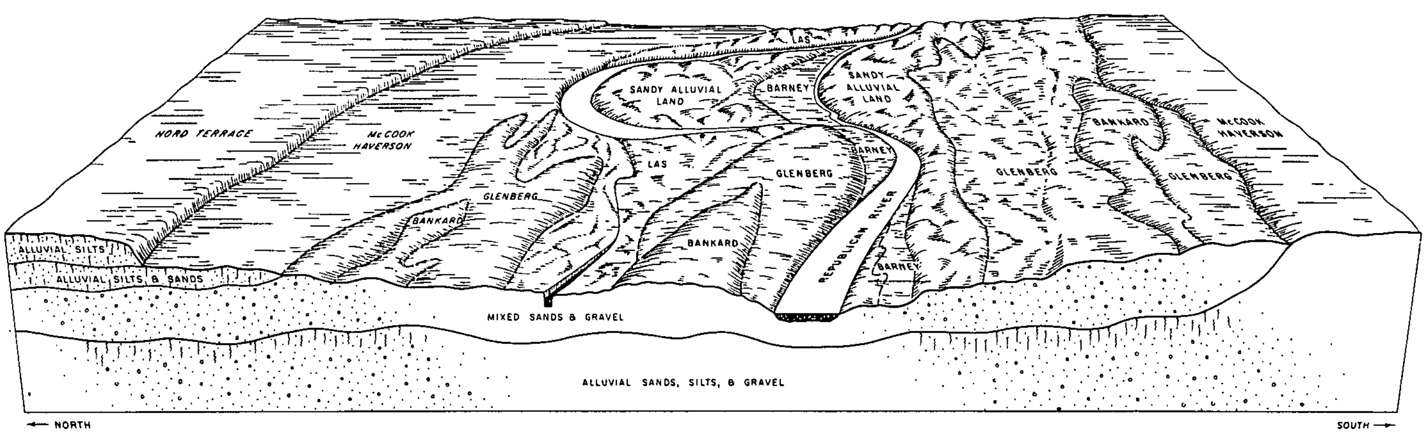


Figure 4.—**Pattern of soils in the Sandy alluvial land-Las-Glenberg association.**

Bankard soils are on lowlands along the Republican River, and the poorly drained Barney soils are in old stream channels.

Soils of this association are generally not suited to cultivation, because they are sandy, poorly drained, or severely affected by salts or alkali.

4. Colby Association

Silty soils on the steep loess hills and in canyons

The soils in this association are on steep loess hills and in canyons that form the valley slopes of most drainageways in the county. The total area is 125,000 acres, or more than 27 percent of the county. Colby soils make up 85 percent of the area, and Ulysses soils 5 percent. Rough broken land, loess, and Rough broken land, caliche, on the sides of canyons, and Broken alluvial land, along the narrow valleys, make up the rest of the area.

The moderately sloping to steep Colby soils are deep and silty and have a thin, slightly darkened surface layer. Below is a light-colored, silty substratum that contains lime.

The Ulysses soils are mostly in the moderately sloping loess hills. The profile of these soils is intermediate in development between that of the Holdrege and Keith soils and the Colby soils. Lime is at a depth of 5 to 15 inches in areas under native grass, but it is at or very near the surface in cultivated areas.

The slopes make the soils in this association better suited to pasture than to row crops, and the Colby soils are gen-

erally used for pasture, though a few small areas are cultivated. The main vegetation in the pastures is blue grama, sideoats grama, western wheatgrass and little bluestem.

Descriptions of the Soils

In this section each soil series is described and important features that apply to all the soils in the series are discussed. The location of the soils in the county and their position in the landscape are given, a comparison with nearby soils or similar soils is made, and the use of the soils is briefly noted.

Following the description of each series are descriptions of each soil in the series. These descriptions generally tell how the various layers or horizons of the soil profile differ from the layers described as representative of the series. The description of each soil also tells about the suitability of the soil for agriculture, its use, and something about its management.

A detailed description of each soil series is provided in the section "Detailed Descriptions of Soil Series." For more general information about the soils, refer to the section "General Soil Map," which describes the broad patterns of soils in the county.

Some of the terms used in the soil descriptions are defined in a preceding section "How This Survey Was Made," and other terms are defined in the Glossary. The acreage and proportionate extent of each soil mapped are given in table 1. The location and extent of the soils in the county are given on the detailed soil map at the back of this report.

Bankard Series

In the Bankard series are nearly level to very gently sloping, light-colored, sandy soils that formed in alluvium. These soils are on ridges or hummocks in the lowlands along the Republican River. The surface layer is light brownish-gray loamy fine sand or fine sand. The rest of the profile consists of light brownish-gray or pale-brown, loose sand or is a mixture of sand and gravel from the river. In some places there are thin, stratified layers of finer materials, which are generally the only part of the soil profile that is calcareous.

These soils are near the Glenberg soils, and they are also near Sandy alluvial land. They are coarser textured than the Glenberg soils and better drained than Sandy alluvial land. Bankard soils also have a more uniform surface than Sandy alluvial land and are in higher positions in the lowlands.

The acreage of these soils is small. The loamy fine sands are mostly cultivated, but the fine sands are suited only to grass. The main plants in the pasture are prairie sandreed, sand lovegrass, switchgrass, indiangrass, and the bluestems. Soil blowing is the main hazard. In addition, the fertility and moisture-holding capacity of the soils are low. Growing crops that produce stubble or using stubble-mulch tillage helps to hold the soils in place.

Bankard fine sand (0 to 2 percent slopes) (Bb).—This nearly level to very gently sloping soil is on ridges or hummocks on lowlands along the Republican River.

TABLE 1.—*Approximate acreage and proportionate extent of the soils*

Soil	Acres	Percent
Bankard fine sand	495	0. 1
Bankard loamy fine sand	455	. 1
Barney silty clay loam	1, 335	. 3
Bayard fine sandy loam, 0 to 1 percent slopes	365	. 1
Bayard fine sandy loam, 1 to 3 percent slopes	270	. 1
Bayard loam, slightly wet	355	. 1
Bridgeport silt loam, 0 to 1 percent slopes	3, 225	. 7
Bridgeport silt loam, 1 to 3 percent slopes	6, 510	1. 4
Bridgeport silt loam, 3 to 6 percent slopes	1, 965	. 4
Broken alluvial land	1, 720	. 4
Colby silt loam, 3 to 9 percent slopes	11, 000	2. 4
Colby silt loam, 9 to 30 percent slopes	122, 795	26. 8
Glenberg fine sandy loam	2, 340	. 5
Glenberg fine sandy loam, slightly wet	2, 340	. 5
Glenberg loam	610	. 1
Haverson fine sandy loam	875	. 2
Holdrege and Keith silt loams, 0 to 1 percent slopes	7, 480	1. 6
Holdrege and Keith silt loams, 1 to 3 percent slopes	28, 510	6. 2
Holdrege and Keith silt loams, 1 to 3 percent slopes, eroded	123, 300	26. 9
Holdrege and Keith silt loams, 3 to 6 percent slopes	2, 290	. 5
Holdrege and Keith silt loams, 3 to 6 percent slopes, eroded	34, 175	7. 4
Hord silt loam, 0 to 1 percent slopes	11, 510	2. 6
Hord silt loam, terrace, 0 to 1 percent slopes	17, 565	3. 8
Hord silt loam, terrace, 1 to 3 percent slopes	2, 675	. 6
Hord-slickspot complex	430	. 1
Las loam	1, 505	. 3
Las loam, saline-alkali	825	. 2
Las sand, overwash	185	(1)
McCook loam, overflow	12, 685	2. 8
McCook and Haverson loams	6, 535	1. 4
Rough broken land, caliche	860	. 2
Rough broken land, loess	8, 710	1. 9
Sandy alluvial land	4, 280	. 9
Ulysses silt loam, 3 to 6 percent slopes, eroded	1, 100	. 3
Ulysses silt loam, 6 to 9 percent slopes	18, 450	4. 0
Ulysses silt loam, 6 to 9 percent slopes, eroded	16, 700	3. 7
Rivers and miscellaneous lands	1, 815	. 4
Total	458, 240	100. 0

[1] Less than 0.05 percent.

This soil is best suited to pasture. Because of its very sandy texture and severe hazard of wind erosion, it is not suited to cultivation. Capability unit VIe–5, dryland; Sands range site; Very Sandy windbreak group.

Bankard loamy fine sand (0 to 2 percent slopes) (Bc).—This soil has a loamy surface layer but is otherwise similar to the soil described for the series. It is nearly level to very gently sloping and is on ridges or hummocks in the lowlands along the Republican River. The surface layer is 6 to 16 inches of granular loamy fine sand that rests on very sandy sediments laid down by the river.

This soil is suited to cultivation, though it must be cultivated with care to control soil blowing. Close-growing crops and stubble-mulch tillage help control soil blowing and conserve moisture. Capability unit IIIe–5, dryland or irrigated; Sands range site; Slightly Sandy windbreak group.

Barney Series

In the Barney series are shallow, poorly drained, dark-colored soils that formed in alluvium. These soils are in long, narrow areas or in crescent-shaped areas adjacent to the Republican River. The areas formerly were a part of river channels. The surface layer is very dark gray silt loam to silty clay loam 4 to 8 inches thick that was laid down by floodwater. It overlies sand and gravel from the river.

These soils are not suited to cultivation, because they are too moist and too shallow. They are best suited to grass that provides food and cover for wildlife. The plants consist mainly of willow saplings and of prairie cordgrass and other coarse prairie grasses but include some indiangrass and switchgrass.

Barney silty clay loam (0 to 2 percent slopes) (Bn).—This is the only Barney soil mapped in the county. It consists of fine-textured sediments and is in oxbows or old abandoned river channels adjacent to the Republican River. The areas are subject to flooding. Capability unit Vw–1, dryland; Wetland range site; Wet windbreak group.

Bayard Series

The Bayard series is made up of deep, nearly level to gently sloping, moderately sandy, moderately dark soils that are well drained. These soils formed in sandy alluvium on fans or on colluvial foot slopes.

The surface soil is grayish-brown, granular fine sandy loam. Below is about 12 to 16 inches of grayish-brown or light grayish-brown sandy loam. This material grades to light grayish-brown sandy loam at a depth of 30 to 36 inches. The layers below the surface soil generally contain calcium carbonate.

Bayard soils are near the Bridgeport soils. They are coarser textured throughout than the Bridgeport soils.

These soils are well suited to dryland and irrigation farming. The main crops are corn, sorghum, and alfalfa. Conserving moisture and controlling wind erosion are the main problems.

Bayard fine sandy loam, 0 to 1 percent slopes (Bf).—This nearly level soil is on fans and foot slopes. Its profile is similar to that described for the Bayard series.

This soil is well suited to both dryland and irrigation farming. Controlling soil blowing and conserving moisture are the main problems. Stubble-mulch tillage helps to prevent soil blowing and to conserve moisture. Capability unit IIe–3, dryland or irrigated; Sandy range site; Slightly Sandy windbreak group.

Bayard fine sandy loam, 1 to 3 percent slopes (BfA).—This very gently sloping soil is on fans and foot slopes. The surface soil is 7 to 12 inches thick, but the soil is otherwise similar to that described for the series.

This soil is well suited to dryland and irrigation farming. If this soil is irrigated, however, the irrigation system may require protection from floodwaters from higher lying areas. The soil is subject to blowing if a protective cover is not maintained.

Stubble-mulch tillage helps to keep the soil from blowing and to conserve moisture. Capability unit IIIe–3, dryland; IIe–3, irrigated; Sandy range site; Slightly Sandy windbreak group.

Bayard loam, slightly wet (0 to 1 percent slopes) (2Bk).—This soil has a loamy surface layer and a water table at a depth of 2 to 6 feet but is otherwise similar to the soil described for the series.

This soil is better suited to grass than to cultivated crops. It can be cultivated in dry years, however, and corn, sorghum, and alfalfa are the main crops. If suitable outlets are available, some areas can be drained and cultivated. Capability unit IIw–4, dryland or irrigated; Subirrigated range site; Moderately Wet windbreak group.

Bridgeport Series

In the Bridgeport series are deep, moderately dark, friable, silty soils that are nearly level to gently sloping. These soils formed in recent deposits of deep, loamy material. They are along the bottoms of slopes in the uplands and in high areas along streams in the lowlands.

The surface layer is grayish-brown to dark grayish-brown, granular silt loam that is 6 to 12 inches thick. It grades to a layer of grayish-brown, granular silt loam 9 to 18 inches thick that is transitional to the substratum. The substratum is massive, light-gray silt loam. In some places an old, buried, dark-colored soil is in the transitional layer or is in the upper part of the substratum.

These soils have an excessive amount of lime at or near the surface, and they have a moderate content of organic matter. They absorb water readily, are easy to work, and have moderate water-holding capacity.

Bridgeport soils are near the Hord soils, terrace phase. They are lighter colored than those soils, have less distinct profiles, and also have lime nearer the surface. Bridgeport soils are similar to the Ulysses soils of the uplands but, unlike those soils, lack a weakly formed subsoil.

These soils are among the most productive in the county, but if they are left without a protective cover, they are subject to wind and water erosion. Corn is the main crop grown, and yields are good if moisture is available. Sorghum, alfalfa, and wheat are also grown. Fertilizer is needed for high yields.

Bridgeport silt loam, 0 to 1 percent slopes (Br).—This nearly level soil is on colluvial-alluvial slopes in high areas along streams. The surface layer is granular silt loam 6 to 12 inches thick, and it grades to a substratum of calcareous silt loam.

This soil is well suited to both dryland and irrigation farming. Corn, sorghum, wheat, and alfalfa are suitable crops. Yields are good, and if proper management is used, this soil is one of the most productive in the county. The main factor limiting yields in dryfarmed areas is lack of moisture. Iron and zinc are deficient in many places. Capability unit IIc–1, dryland; I–1, irrigated; Silty range site; Silty to Clayey windbreak group.

Bridgeport silt loam, 1 to 3 percent slopes (BrA).—This soil has very gentle slopes but is otherwise similar to the soil described for the series.

If this soil is smoothed or bench leveled for irrigation, use and management are similar to those for Bridgeport silt loam, 0 to 1 percent slopes. Dryfarmed areas can be cultivated, and yields are good if the soil is properly managed and stubble mulching is used. Controlling water and conserving moisture are problems in dryfarmed areas because the soil is low in organic matter. Capability unit

IIe-1, dryland or irrigated; Silty range site; Silty to Clayey windbreak group.

Bridgeport silt loam, 3 to 6 percent slopes (BrB).—This gently sloping soil is on colluvial-alluvial slopes. It has a surface layer that is 6 to 10 inches thick, but it is otherwise similar to the soil described for the series.

This soil can be bench leveled for irrigation. If it is smoothed, use and management are similar to those for Bridgeport silt loam, 0 to 1 percent slopes. Yields from dryfarmed areas that are cultivated are comparable to those for Holdrege and Keith silt loams, 3 to 6 percent slopes. Controlling water erosion and conserving moisture are the main problems in dryfarmed areas. Capability unit IIIe-1, dryland or irrigated; Silty range site; Silty to Clayey windbreak group.

Broken Alluvial Land

Broken alluvial land (0 to 15 percent slopes) (Sy) is made up of deep, medium-textured soil material in narrow valleys along drainageways that lead to major streams. The areas consist of unconsolidated alluvium recently deposited by overflow from streams. They are deeply entrenched by channels of the meandering streams. Abruptly sloping channel banks and an uneven surface between the channels are characteristic of the areas. The soil material has been in place long enough for plants to become established, and the deposits were laid down too recently for formation of a distinct soil profile.

Most areas of Broken alluvial land are pastured. Some small, smooth areas lack deeply cut channels and are suited to cultivation. Crops in these areas are frequently damaged or washed out by floods. Capability unit VIw-1, dryland; Overflow range site; Moderately Wet windbreak group.

Colby Series

The Colby series is made up of thin, light-colored, friable, silty soils that are moderately sloping to strongly sloping and are well drained. These soils formed in thick deposits of Peorian loess, which is a light-colored, silty material. They occur throughout the county.

In uneroded areas the surface layer is friable, grayish-brown silt loam that is 4 to 6 inches thick and has weak, granular structure (fig. 5). Below is grayish-brown to light brownish-gray silt loam 6 to 10 inches thick that is transitional to the substratum. The substratum is massive, light-gray silt loam and is many feet thick. These soils have lime at or near the surface. Because of the strong slope, runoff is rapid.

Colby soils are near the Keith, Holdrege, and Ulysses soils, but they have lime much nearer the surface than any of those soils. They also are less well developed and are lighter colored than those soils.

The Colby soils are used mainly for pasture. The main plants in the pastures are blue grama, sideoats grama, western wheatgrass, and little bluestem.

Some areas of Colby soils that have slopes of 3 to 9 percent are cultivated. The soils in these areas are low in organic matter and are marginal for crops. They ought to be reseeded to native grass, since they soon erode severely when cultivated.

Colby silt loam, 3 to 9 percent slopes (CbCW).—This soil has a thinner, lighter colored surface soil but otherwise has a profile similar to that described as typical of the series. Slopes range from gentle to moderate but are predominately moderate. This soil is calcareous at the surface.

In cultivated areas this soil has lost most of its surface layer through erosion, and plowing has mixed material from the light-colored substratum with the remaining surface layer. Yields of crops on this soil are marginal. The soil is therefore best suited to range. Capability unit IVe-8, dryland; Thin Silty range site; Silty to Clayey windbreak group.

Colby silt loam, 9 to 30 percent slopes (CbDW).—The profile of this soil is the one described for the series. This strongly sloping soil is on the sides of valleys along numerous small drainageways that occur throughout the county. The surface is generally uneven, but in some places smooth convex and concave slopes lie between the drainageways.

Included with this soil in mapping are small areas of Ulysses and Bridgeport soils, Broken alluvial land, and Rough broken land. These included areas are along drainageways.

This Colby soil is suited only to grass. Blue grama, sideoats grama, western wheatgrass, and little bluestem

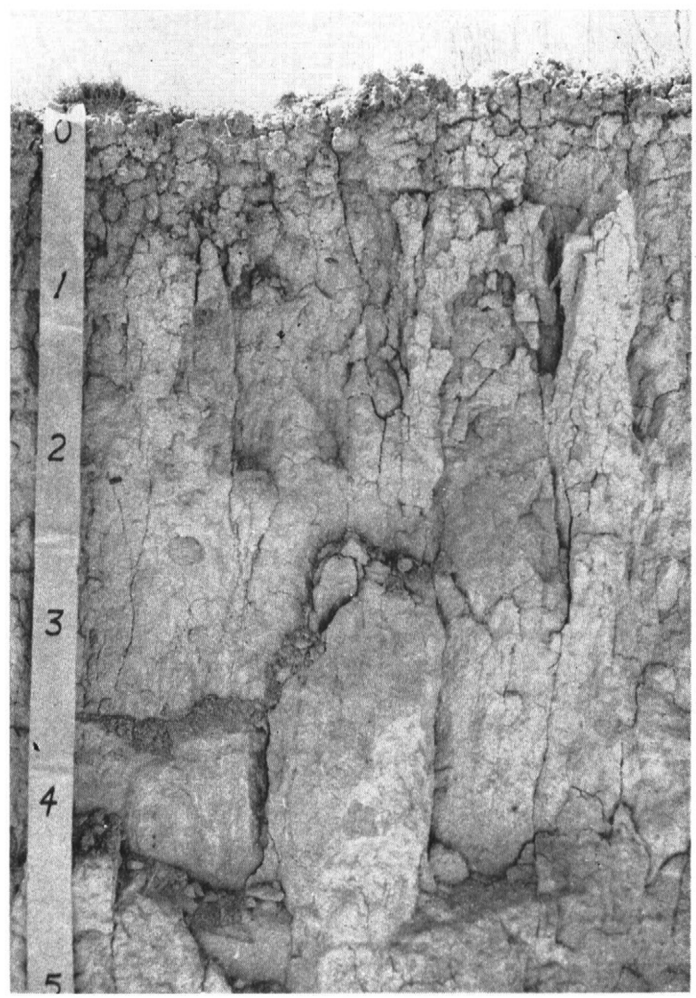


Figure 5.—**Profile of Colby silt loam; the measure is marked in feet.**

are the main plants in the pastures. Small areas of this soil adjacent to smoother areas in the uplands are cultivated, even though severely eroded. These severely eroded areas are shown by conventional symbol on the detailed soil map. Capability unit VIe–9, dryland; Thin Silty range site; Silty to Clayey windbreak group.

Glenberg Series

In the Glenberg series are nearly level to very gently sloping, deep, light-colored, calcareous, moderately sandy soils that are well drained to somewhat poorly drained. These soils are on bottom lands along the Republican River. The surface layer is light brownish-gray to grayish-brown loam to fine sandy loam that is granular and about 13 inches thick. Below is grayish-brown or light brownish-gray fine sandy loam. Sand and gravel from the river are at a depth of 3 feet or more. These soils are calcareous at the surface.

Glenberg soils are near the McCook and Bankard soils. Their subsoil is coarser textured than that of the McCook soils and finer textured than that of the Bankard soils.

The Glenberg soils are suited to corn, sorghum, alfalfa, and wheat, but the imperfectly drained areas are best suited to grass. Wind erosion is a hazard if the soils are left unprotected.

Glenberg fine sandy loam (0 to 2 percent slopes) (Gd).—This soil has a surface layer of fine sandy loam 13 inches thick. In a few places, however, the surface layer is loamy fine sand. Controlling soil blowing and conserving moisture are the main problems.

This soil is well suited to dryland and irrigation farming. Corn and sorghum are the main crops. Capability unit IIe–3, dryland or irrigated; Sandy range site; Slightly Sandy windbreak group.

Glenberg fine sandy loam, slightly wet (0 to 1 percent slopes) (2Gd).—This soil has a water table at a depth of 2 to 6 feet but is otherwise similar to the soil described for the series.

If the water table is low because of drainage or dry weather, this soil can be cultivated with little difficulty. The main crops are corn, sorghum, and alfalfa, but this soil is also well suited to grass. Yields of pasture and hay are high. Capability unit IIw–6, dryland or irrigated; Subirrigated range site; Moderately Wet windbreak group.

Glenberg loam (0 to 1 percent slopes) (GK).—This soil has a surface layer of loam, but its profile is otherwise similar to that described as typical for the series. The surface layer is about 12 inches thick. Below is about 2 or 3 feet of fine sandy loam underlain by 3 feet or more of sand and gravel from the river.

This is one of the best bottom-land soils in the county. Controlling soil blowing and conserving moisture are the major problems. Stubble mulching holds the soil in place. This soil is well suited to dryland and irrigation farming, and corn, sorghum, and alfalfa are the main crops. Capability unit I–1, dryland or irrigated; Silty range site; Silty to Clayey windbreak group.

Haverson Series

The Haverson series is made up of deep, nearly level, well-drained, friable, silty soils. These soils are in the lowlands along all the major streams in the county. The surface layer is calcareous, grayish-brown, granular loam or fine sandy loam that is 8 to 18 inches thick. Below is silty alluvium that in some places is an old, dark-colored, buried soil but in others is a light brownish-gray silt loam that has weak, granular structure and is 18 to 24 inches thick. This silty alluvium generally grades to light-colored fine sandy loam or fine sand at a depth of 3 to 4½ feet. All layers in the profile contain much calcium carbonate. These soils absorb water readily, are easy to work, and have moderate water-holding capacity.

Haverson soils are near the Las and Glenberg soils. They are better drained than the Las soils, and they have a finer textured subsoil than the Glenberg soils.

The Haverson soils are among the most productive in the county. The main crop is corn, and yields are high in most years. Other crops grown are sorghum and alfalfa. Wind erosion is a hazard if the surface is left unprotected.

Haverson fine sandy loam (0 to 1 percent slopes) (Hf).—This is the only Haverson soil mapped in the county. It has a surface layer of fine sandy loam 1 to 1½ feet thick.

This soil is well suited to irrigation, but lack of moisture limits yields in years when rainfall is low. Corn, sorghum, and alfalfa are the main crops. The soil is subject to blowing if a protective cover is not maintained. Stubble mulching helps to hold the soil in place and to build up the supply of organic matter. Capability unit IIe–3, dryland or irrigated; Sandy range site; Slightly Sandy windbreak group.

Holdrege Series

The Holdrege series is made up of nearly level to gently sloping, moderately dark colored, silty soils that are well drained. These soils formed in the uplands on thick deposits of Peorian loess. They are mostly in the eastern two-thirds of the county, but they are also on smoother slopes throughout the county.

The surface layer is dark grayish-brown, granular silt loam 6 to 16 inches thick (fig. 6). It grades to a subsoil of grayish-brown, friable silt loam or heavy silt loam that is slightly lighter colored than the surface layer and is 12 to 20 inches thick. The subsoil has weak to moderate, blocky structure and in places is calcareous in the lower part. Below is light brownish-gray to light-gray, unweathered loess that is strongly calcareous and is many feet thick. The soils absorb water readily, are easy to work, and have moderate water-holding capacity.

These soils are near the Keith soils and the Ulysses and Colby soils. They have a slightly finer textured and more distinct subsoil than the Keith soils. Holdrege soils are less sloping than the Ulysses and Colby soils. They also have a thicker and darker profile and are leached of calcium carbonates to a greater depth.

Holdrege soils are among the most productive in the county. They are subject to wind and water erosion, however, if left without a protective cover. The hazard of erosion is greatest on the steeper slopes.

Wheat is the major crop grown, and yields are good in most years. Grain sorghum, corn, and alfalfa are also grown, and a few isolated areas are still in native grass used for pasture. Wheat is generally grown in a system that includes summer fallow, because yields are highest over a long period if fallowing is practiced. The main

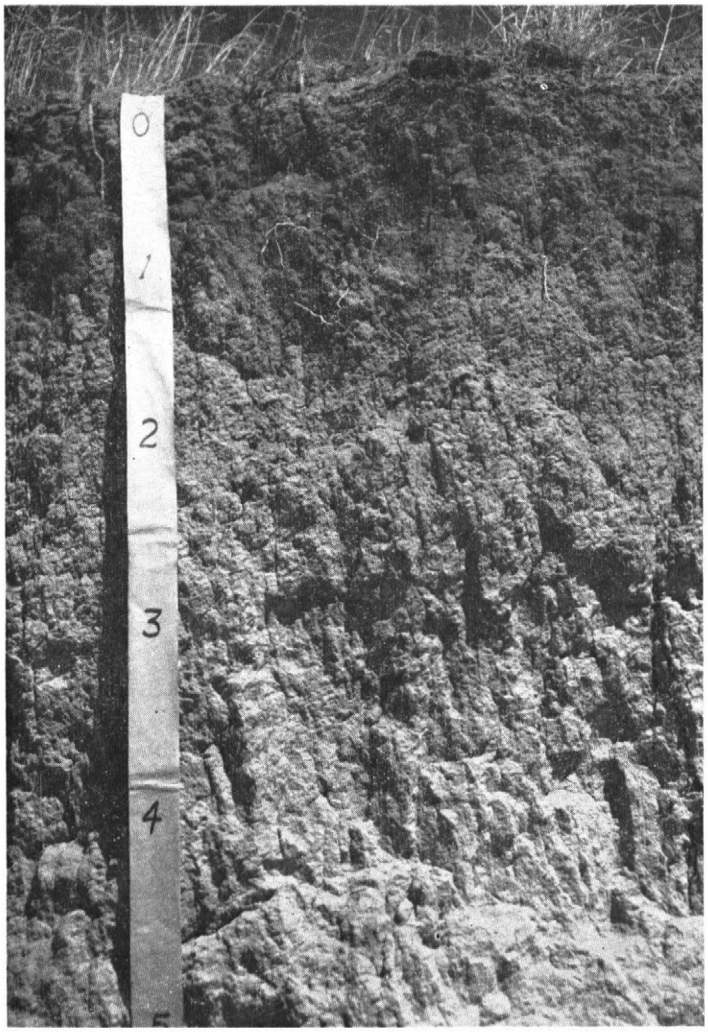


***Figure 6.*—Profile of Holdrege silt loam; the measure is marked in feet.**

plants in the pastures are western wheatgrass, blue grama, sideoats grama, and little and big bluestems.

Holdrege and Keith silt loams, 0 to 1 percent slopes (HK).—This undifferentiated unit consists of nearly level Holdrege and Keith silt loams. These soils are in concave areas in the uplands in the western part of the county. The profile of each is similar to the one described for each series. Holdrege soils make up about 70 percent of this unit, and Keith soils about 30 percent. The surface layer of each soil is about 14 inches thick.

These soils are well suited to dryland and irrigation farming, and nearly all the crops commonly grown in the county are suited. Yields are limited mainly by lack of moisture. Capability unit IIc–1, dryland; I–1, irrigated; Silty range site; Silty to Clayey windbreak group.

Holdrege and Keith silt loams, 1 to 3 percent slopes (HKA).—This undifferentiated unit is made up of very gently sloping Holdrege and Keith silt loams. These soils are on long, smooth slopes throughout the county. The profile of each soil is similar to the one described for each series. Holdrege soils make up about 60 percent of this unit, and Keith soils make up about 40 percent.

The soils in this unit are suited to both dryland and irrigation farming. Yields of wheat, sorghum, and corn are good. Lack of moisture is the main factor limiting yields. Level terraces and stubble-mulch tillage help to control erosion and to conserve moisture. Capability unit IIe–1, dryland or irrigated; Silty range site; Silty to Clayey windbreak group.

Holdrege and Keith silt loams, 1 to 3 percent slopes, eroded (HKA2).—This undifferentiated unit is made up of very gently sloping Holdrege and Keith silt loams. These soils are in the uplands throughout the county, on ridgetops and in cultivated fields. About 60 percent of the unit consists of Holdrege soils, and 40 percent of Keith soils. Each of the soils has a thinner surface layer and a thinner profile but is otherwise similar to the soil described for its series. The surface layer of each soil is about 8 inches thick. The soils are moderately eroded, and in places plowing has mixed material from the subsoil with the remaining surface layer.

These soils are well suited to all major crops grown in the county. Conserving moisture and controlling erosion are the major problems. Level terraces and stubble-mulch tillage are common practices that help conserve moisture and control erosion. Capability unit IIe–1, dryland or irrigated; Silty range site; Silty to Clayey windbreak group.

Holdrege and Keith silt loams, 3 to 6 percent slopes (HKB).—This undifferentiated unit is made up of Holdrege and Keith silt loams. These soils occur throughout the county. Each soil has a profile similar to the one described for its series. Holdrege soils make up about 40 percent of this unit, and Keith soils make up about 60 percent.

These soils are used mainly for pasture. If they are cultivated, lack of moisture and erosion are the main hazards.

Level terraces and stubble-mulch tillage help to conserve moisture and control erosion. If the soils are left in native grass, proper range use helps produce favorable yields. Capability unit IIIe–1, dryland or irrigated; Silty range site; Silty to Clayey windbreak group.

Holdrege and Keith silt loams, 3 to 6 percent slopes, eroded (HKB2).—This undifferentiated unit occurs throughout the county. It is made up of gently sloping Holdrege and Keith silt loams. Each soil has a thinner surface layer, but its profile is otherwise similar to the one described for its series. The soils are eroded and their surface layer is therefore about 8 inches thick.

About 60 percent of this unit consists of Keith soils, and 40 percent consists of Holdrege soils. These soils are cultivated and are suited to all the major crops grown in the county. Controlling erosion and conserving moisture are the main problems. Terraces and stubble-mulch tillage are common practices that help to control erosion and conserve moisture. Capability unit IIIe–1, dryland or irrigated; Silty range site; Silty to Clayey windbreak group.

Hord Series

In the Hord series are deep, dark, nearly level, silty soils that are well drained. These soils are in the uplands or are on high stream terraces. They have formed in loess, and their surface layer has been thickened by slow accumulation of recent loess.

The surface layer is very dark grayish-brown, granular silt loam 16 to 24 inches thick. It grades to a subsoil of grayish-brown, friable silt loam or heavy silt loam that has weak, blocky structure and is 18 to 30 inches thick. The substratum is light-gray loam. The soils in the uplands are calcareous at a depth of about 24 inches, but those that are on the terraces are calcareous at a depth between 36 and 48 inches. All the soils absorb water readily, are easily tilled, and have moderate water-holding capacity.

In the uplands Hord soils are near the Keith and Holdrege soils. They are darker colored to a greater depth than those soils, and unlike those soils are only in nearly level or concave areas. On the terraces Hord soils are near the Bridgeport soils. They are darker colored than those soils, however, have more distinct profiles, and are leached of lime to a greater depth.

Hord soils are suited to irrigation. They are among the most productive soils in the county, and most areas are cultivated. In the uplands wheat is the principal crop, but on the terraces the main crop is corn. All the major crops grown in the county are suited to these soils. Yields are limited mainly by lack of moisture. Moisture can be conserved by proper use of crop residues. The use of summer fallow in the rotations also helps conserve moisture in many areas.

Hord silt loam, 0 to 1 percent slopes (Hd).—This nearly level soil occurs throughout the uplands. It has a profile like that described for the series. The surface soil ranges from 16 to 24 inches in thickness and averages 20 inches.

This soil is well suited to cultivation, and all of the crops grown in the county are well suited. Yields are limited mainly by lack of moisture. The proper use of crop residues and summer fallowing help to conserve moisture. Capability unit IIc–1, dryland; I–1, irrigated; Silty range site; Silty to Clayey windbreak group.

Hord silt loam, terrace, 0 to 1 percent slopes (2Hd).—The profile of this soil is similar to the one described for the series, but it is leached of calcium carbonates to a greater depth. This soil is on nearly level stream terraces along the Republican River, Beaver Creek, and the main tributaries of those streams. In places this soil is more stratified than the Hord soils in the uplands.

This soil is well suited to cultivation (fig. 7), and all the major crops grown in the county are suitable. Because of its position on terraces, the moisture supply is better than in most soils above the flood plains and the soil is more fertile. Irrigation water also can be obtained at less depth, and little preparation is needed before irrigating. Capability unit IIc–1, dryland; I–1, irrigated; Silty range site; Silty to Clayey windbreak group.

Figure 7.—**Typical winter landscape of Hord silt loam, terrace, 0 to 1 percent slopes, in the Republican River valley. Most of this soil is in irrigated crops.**

Hord silt loam, terrace, 1 to 3 percent slopes (2HdA).—This very gently sloping soil is on stream terraces. It is more sloping, the surface layer is slightly thinner, and calcium carbonates are leached to a greater depth, but it is otherwise similar to the soil described for the series. This soil is along the Republican River and Beaver Creek and the main tributaries of those streams. In some places an older buried soil and thin layers that have coarser and finer texture are in this soil.

This soil is well suited to dryland and irrigation farming, and all of the major crops grown in the county are suited. Controlling erosion and conserving moisture are the main problems. Terracing, the proper use of crop residues, and summer fallowing help conserve moisture. These practices also help to control erosion. Capability unit IIe–1, dryland or irrigated; Silty range site; Silty to Clayey windbreak group.

Hord-slickspot complex (0 to 2 percent slopes) (HSs).—This complex consists of nearly level soils on stream terraces, mainly north of Perry. These soils are near the base of slopes in the uplands in depressions that collect seepage. This complex consists of Hord silt loam and of scattered, small slick spots. The Hord silt loam in this complex is similar to the soil described for the series.

The slick spots make up only about 25 percent of the complex, but the areas are large enough to influence the use of the soils and yields of crops. They have a surface layer of silt loam, and their subsoil is columnar silty clay loam. The substratum is gravelly silt loam or fine sandy loam. These slick spots contain salts and alkali and are very strongly alkaline.

Corn and sorghum are grown in some areas of this complex, but because of the slick spots, high yields are not expected. The areas are best suited to grass. Drainage and soil amendments are needed to alleviate the effects of the alkali. Capability unit IVs–1, dryland; IIIs–1, irrigated; Silty range site; Moderately Saline-alkali windbreak group.

Keith Series

In the Keith series are dark, well-drained, silty soils that formed in thick deposits of highly calcareous Peorian loess. These soils are in gently sloping uplands throughout the county. They are predominant on the nearly level divides in the western one-third of the county and on steeper slopes throughout the county.

The surface layer is dark grayish-brown, granular silt loam that is 6 to 16 inches thick. It grades to a subsoil of friable, dark grayish-brown to brown silt loam that is slightly lighter colored than the surface layer. The subsoil is 12 to 20 inches thick, has weak to moderate, blocky structure, and in places is calcareous in the lower part. The underlying substratum is light-gray silt loam that is many feet thick.

Keith soils are near the Holdrege, Ulysses, and Colby soils. In contrast to the Holdrege soils, Keith soils have a less distinct subsoil and are silt loam throughout. They

are darker than the Ulysses and Colby soils, have a more distinct subsoil, and are leached of lime to a greater depth. They are also less sloping.

Keith soils are among the most productive soils in the county. They absorb water readily, are easy to till, and have moderate water-holding capacity. If these soils are left without a protective cover, however, they are susceptible to wind and water erosion. Erosion is more serious in the gently sloping areas than in the nearly level ones.

Wheat is the major crop grown on these soils, and yields are good in most years. Other crops grown are grain and forage sorghums, corn, and alfalfa. Some isolated areas are still in native grasses. Wheat is generally grown in a cropping system that includes summer fallow because long-time yields are highest if this is done. The main plants in the pastures are western wheatgrass, blue grama, sideoats grama, and little and big bluestems.

In this county Keith soils are mapped only in undifferentiated units with the Holdrege soils.

Las Series

The Las series is made up of light-colored, calcareous soils that are imperfectly drained. These soils are on lowlands along the Republican River.

The surface layer is grayish-brown loam or silt loam that has granular structure and is 8 to 16 inches thick. Below is grayish-brown, weak, subangular blocky silt loam, from alluvium, that grades to the substratum at a depth of 3 to 6 feet. The substratum is fine sandy loam to sand and gravel and has a water table. All the layers in the profile contain lime. The amount of alkali and soluble salts varies in some areas.

Las soils are near the Glenberg and McCook soils. They are finer textured throughout than the Glenberg soils and are not so well drained as the McCook soils.

The Las soils are better suited to alfalfa, wheat, corn, sorghum, and grass than to other uses. In wet seasons yields are limited by wetness. The plants in pastures are mainly switchgrass, indiangrass, and big bluestem.

Las loam (0 to 1 percent slopes) (Lt).—This soil has a surface layer of loam or silt loam 8 to 16 inches thick. Below is silty material that grades to coarse sediments in the substratum, which has a water table.

This soil is suited to cultivated crops and to pasture consisting of native grass. Yields are limited in wet seasons because then the water table is near the surface. The most suitable crops are corn, wheat, sorghum, and alfalfa. Capability unit IIw-4, dryland or irrigated; Subirrigated range site; Moderately Wet windbreak group.

Las loam, saline-alkali (0 to 1 percent slopes) (2Lt).—This soil contains moderate amounts of alkali or soluble salts but otherwise is similar to the soil described for the series. The location and the amount of alkali or soluble salts throughout the profile vary greatly. In some places the soil is slightly affected by alkali or soluble salts, but in other places it is severely affected.

On this soil yields of most crops are low, but yields of alfalfa are moderate. This soil is well suited to pastures of native grass. Management of the areas for pasture is not difficult. Capability unit IVs-1, dryland; IIIs-1, irrigated; Saline Subirrigated range site; Moderately Saline-alkali windbreak group.

Las sand, overwash (0 to 1 percent slopes) (2Lz).—This soil is in areas adjacent to an old river channel or to the Republican River. The surface layer is brown or pale-brown loamy fine sand or fine sand 8 to 16 inches thick. The sand was laid down by floodwater, and in some places the surface is slightly hummocky. The underlying material is silt loam but grades to sand and gravel at a depth of 30 to 48 inches.

Cultivated crops can be grown on this soil, but yields are low. This soil is well suited to grass. Capability unit IVw-5, dryland; IIIw-5, irrigated; Subirrigated range site; Moderately Wet windbreak group.

McCook Series

The McCook series is made up of deep, nearly level, moderately dark, silty soils that are well drained. These soils formed in alluvium on high bottom lands along the Republican River, Beaver Creek, and the main tributaries of these streams.

The surface layer is grayish-brown loam or silt loam. It grades to a substratum (fig. 8) of light brownish gray or light gray. The soils are medium textured to a depth of

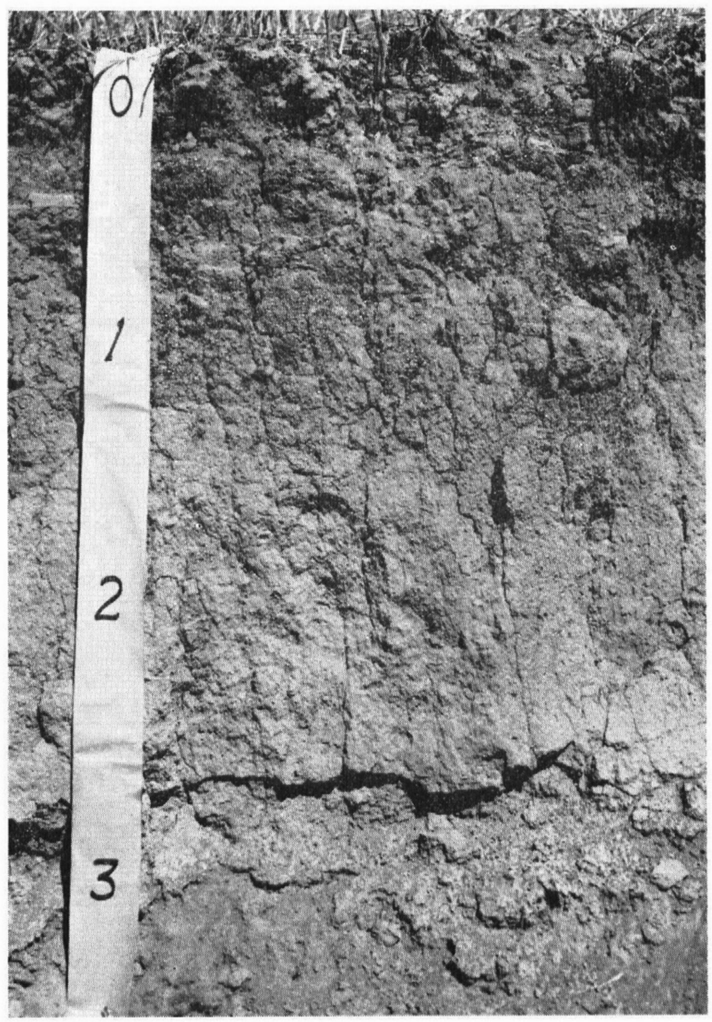


Figure 8.—**Profile of McCook loam; the measure is marked in feet.**

3 feet or more. In many places layers of sand and gravel or sandy loam or fine sandy loam are at a depth below 40 inches.

McCook soils are near the Glenberg and Haverson soils. They are finer textured than the Glenberg soils and are darker to a greater depth than the Haverson soils.

These soils are suited to irrigation and are among the most productive soils in the county. All of the major crops grown in the county are suitable. Lack of moisture in dry years and maintaining fertility are the only problems.

McCook loam, overflow (0 to 1 percent slopes) (2Mg).—This soil is in areas that are flooded in places for short periods. Because of flooding the profile is more stratified than that described for the series, and depth to sand and gravel is greater in places. A few small areas have a surface layer of silty clay loam. Most areas are on bottom lands along Beaver Creek, but some areas throughout the county are on bottom lands of smaller streams and drainageways.

This soil is easy to cultivate, and corn and sorghum are the main crops. Yields are high. The soil is well suited to irrigation. Flooding is the main hazard, but practices used in the uplands, as well as large dams and other structures for control of floods, help to reduce the frequency of flooding. Capability unit IIw-3, dryland or irrigated; Overflow range site; Moderately Wet windbreak group.

McCook and Haverson loams (0 to 1 percent slopes) (MH).—This undifferentiated unit consists of McCook and Haverson loams. The profile of each soil is like the one described for its series. The darker color in the McCook soils extends to a greater depth than that of the Haverson soils. The thickness of the surface layer of each soil ranges from 8 to 18 inches. The substratum is silt loam to a depth of 3 feet or more. All layers in the profile contain thin stratified sandy material.

These soils are well suited to irrigation, and all the crops commonly grown in the county are suitable. Capability unit I-1, dryland or irrigated; Silty range site; Silty to Clayey windbreak group.

Rough Broken Land, Caliche

Rough broken land, caliche (15 to 35 percent slopes) (BCa) is in steep and very steep areas that have abrupt slopes. These areas are mostly at the heads of drainageways leading to Red Willow and Beaver Creeks (fig. 9), but some small areas are along slopes that lead to the Republican River. About 50 percent of the areas consists of outcrops of rock of the Ogallala formation. The rest consists of very shallow soils on upper slopes and of deep pockets of soil between the rock outcrops. Runoff is rapid, and little soil formation has taken place.

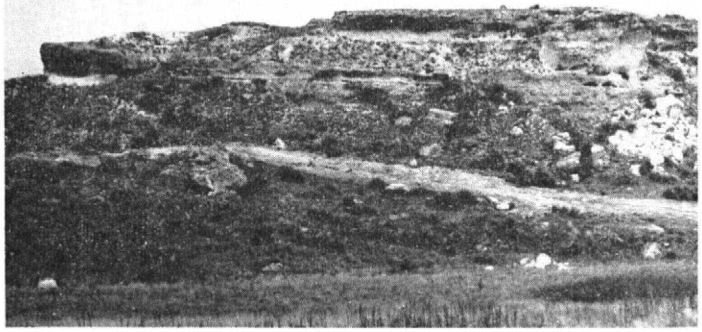


Figure 9.—**A typical area of Rough broken land, caliche.**

Areas of this land type produce only sparse vegetation, and the strong slopes make it difficult for cattle to graze. The areas can be used to provide cover for livestock and wildlife in winter. Capability unit VIIs-3, dryland; Thin Breaks range site; not suitable for windbreaks.

Rough Broken Land, Loess

Rough broken land, loess (15 to 35 percent slopes) (BL) is made up of areas of Broken alluvial land and of Colby silt loam. These steep, broken areas are on short, backward-tilted terraces, or catsteps, along flat, narrow bottoms of drainageways leading to major streams. The surface layer in areas that have not eroded is thin and moderately dark colored. The underlying material is silty, light-colored, calcareous loess that shows little or no formation of a distinct soil profile. Runoff is rapid, and soil slipping is common.

All areas of this land type are in pasture of native grass. The strong slopes make it difficult for cattle to graze the areas. Capability unit VIIe-1, dryland; Thin Loess range site; not suitable for windbreaks.

Sandy Alluvial Land

Sandy alluvial land (0 to 2 percent slopes) (Sx) is a nearly level land type made up of deposits from floodwaters of the Republican River (fig. 10). The deposits are mostly sand but include some silty, stratified alluvium. These deposits have been in place long enough for plants to become established, but they were laid down too recently

Figure 10.—**Typical vegetation on Sandy alluvial land, along the Republican River.**

for formation of a distinct soil profile. Floodwaters have cut channels in the areas and left them hummocky. The slope is therefore irregular. The vegetation consists of annual weeds, native grasses, and trees. Capability unit VIw-5, dryland; Subirrigated range site; Moderately Wet windbreak group.

Ulysses Series

In the Ulysses series are gently sloping to moderately sloping, moderately dark colored, well-drained, silty soils. These soils formed in the uplands in thick deposits of Peorian loess. The surface is smooth, and most of the acreage is moderately sloping.

In pastured areas the surface layer is weak, granular, grayish-brown to dark grayish-brown silt loam that is friable and is 4 to 10 inches thick (fig. 11). The subsoil is grayish-brown silt loam that has weak, subangular blocky structure and is 6 to 16 inches thick. The substratum is light-gray silt loam that contains much lime.

In cultivated areas plowing has mixed some material from the subsoil with the remaining surface layer, and here the soil is lighter colored than in pastured areas. Lime is at or near the surface of the soils in cultivated areas, but in pastured areas it is at a depth of about 12 inches.

Ulysses soils are near the Keith, Holdrege, and Colby soils. They have a thinner surface layer and are lighter colored than the Keith or Holdrege soils, but unlike those soils, lack a distinct profile. Ulysses soils are darker than the Colby soils and have a more distinct profile.

These soils are marginal for cultivation, and about half the acreage is in pasture of native grass. Strong slopes and lack of organic matter make the soils susceptible to both wind and water erosion. Intensive conservation practices are therefore needed. Wheat, other small grains, drilled forage sorghum, and other close-growing crops are needed for the control of erosion. Blue grama, sideoats grama, western wheatgrass, and big and little bluestems are the main plants in the pastures.

Ulysses silt loam, 3 to 6 percent slopes, eroded (UsB2).—This gently sloping soil is in cultivated areas throughout the county, and most areas are south of the Republican River. This soil has a thinner surface layer than that of the one described for the series. The soil is less developed than in other areas, and it is calcareous at or near the surface. The surface soil is 4 to 6 inches thick. In cultivated areas this soil is moderately eroded, and plowing has mixed material from part of the subsoil with the remaining surface layer.

This soil is better suited to small grains than to other uses. It is suited to cultivation, but practices are needed for control of wind and water erosion and to conserve moisture. Capability unit IIIe-1, dryland or irrigated; Thin Silty range site; Silty to Clayey windbreak group.

Ulysses silt loam, 6 to 9 percent slopes (UsC).—The profile of this soil is the one described for the series. The surface soil is 6 to 10 inches thick. Slopes are moderate and average about 8 percent. This soil is not calcareous in the upper 6 inches.

Included with this soil in mapping are some areas that have slopes of as much as 12 percent.

This Ulysses soil is in native pasture. Controlling erosion and conserving moisture are the main problems.

Figure 11.—**Profile of a Ulysses silt loam; the measure is marked in feet.**

Capability unit IVe-1, dryland or irrigated; Silty range site; Silty to Clayey windbreak group.

Ulysses silt loam, 6 to 9 percent slopes, eroded (UsC2).—This moderately sloping soil is in the uplands. It has a thinner, lighter colored surface soil but otherwise has a profile similar to the one described for the series. The surface soil is 4 to 6 inches thick, and the subsoil has weak, subangular blocky structure and is 8 to 12 inches thick. In cultivated areas plowing has mixed material from the subsoil with the remaining surface layer, and the soil is therefore calcareous at or near the surface.

Included with this soil in mapping are small, adjacent areas of Ulysses silt loam, 6 to 9 percent slopes, that are not eroded.

This Ulysses soil is suited to cultivation, but it is low in organic matter and erodes readily. Practices that prevent excessive water erosion are needed. Capability unit IVe-1, dryland or irrigated; Thin Silty range site; Silty to Clayey windbreak group.

Use and Management of Soils

This section discusses the use and management of the soils in Red Willow County for cultivated crops, for rangeland, for woodland and windbreaks, for wildlife, and for engineering. It explains the capability grouping used to classify soils according to their suitability for cultivated crops and predicts yields for soils that are cultivated. Also, it describes the range sites in the county and explains the practices of management appropriate for rangeland.

Managing Cropland

The most common practices used for conserving moisture and controlling erosion are given in this section. These practices can be used in different combinations and in various amounts according to the capability and needs of the soils and their suitability for crops. Assistance in planning and applying such practices can be obtained from local representatives of the Soil Conservation Service or the county agent.

Conserving moisture and controlling water erosion.—The soils of this county require practices that conserve moisture and control water erosion. This can be done by keeping the soils in good tilth so that rain and snow can soak in and as much as possible be retained. Several methods can be used, but best results are obtained if a combination of practices are applied.

Growing legumes, mixtures of grasses and legumes, and green-manure crops in the cropping system, and applying barnyard manure, if available, are ways of improving soil structure and fertility, as well as increasing moisture retention of the soils. Using a cropping system that includes crops that resist droughts helps to retain moisture. In dryland areas, if a field is left fallow for a year before planting a wheat crop, moisture is retained in the soil and yields are increased.

Contour farming, stripcropping, and terracing help keep water from concentrating and thus causing erosion. Such practices slow evaporation of water, and more water therefore soaks into the soil.

Keeping crop residues on the surface or growing a protective cover of plants helps to prevent the soil from sealing or crusting during a hard rain. If tall stubble is left in the fields in winter, it helps to catch snow. Leaving crop residues on the surface helps to form a mulch, which slows evaporation of moisture and checks the drying effect of strong winds.

Cultivating the soils at various depths and when they are not so wet as to clod or pack help to keep a plowpan from forming. Also weeds must be controlled, because they take moisture from the soils that otherwise would be held for the next crop.

Controlling wind erosion.—Practices that help to conserve moisture generally also help to control wind erosion. In this county, however, crops sometimes do not grow well in dry periods. If proper management is not used in a year when moisture is not available or in the preceding year, the soils blow. Among practices commonly used for controlling wind erosion are stubble-mulch tillage, stripcropping, and emergency tillage.

Applying fertilizer.—Soils used for crops require commercial fertilizer, and most irrigated soils also need fertilizer. If adequate fertilizer is applied, yields are high. Enough residue is also produced to help protect the soil from wind and water erosion. The kind and amount of fertilizer applied should be determined by soil tests. The available supply of moisture also must be considered. Soil tests can be obtained from the Nebraska Soil Testing Service, Nebraska College of Agriculture, at Lincoln, Nebr., or from the county agent.

Irrigation practices.—According to the U.S. Census of Agriculture, the land irrigated in Red Willow County in 1959 was 16,127 acres. In planning an irrigation system, there must be (1) ample acreage of soil suited to irrigation, (2) enough water of good quality, and (3) a system for handling the water that is suited to the soil and the lay of the land. Leveling is needed in most areas for efficient use of irrigation water.

Installing an irrigation system is costly, and therefore the cropping systems used and the amount and kinds of fertilizer applied may need to be adjusted greatly for irrigation to pay. Local representatives of the Soil Conservation Service, the county agent, or members of the College of Agriculture, University of Nebraska, can help in planning an irrigation system.

Capability Groups of Soils

Capability classification is the grouping of soils to show, in a general way, their suitability for most kinds of farming. It is a practical classification based on limitations of the soils, the risk of damage when they are used, and the way they respond to treatment. The soils are classified according to degree and kind of permanent limitation, but without consideration of major and generally expensive landforming that would change the slope, depth, or other characteristics of the soils; and without consideration of possible but unlikely major reclamation projects.

In the capability system, all kinds of soils are grouped at three levels, the capability class, subclass, and unit. These are discussed in the following paragraphs.

Capability Classes, the broadest grouping, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use; they are defined as follows:

Class I. Soils in class I have few limitations that restrict their use.

Class II. Soils have some limitations that reduce the choice of plants or require moderate conservation practices.

Class III. Soils have severe limitations that reduce the choice of plants or require special conservation practices, or both.

Class IV. Soils have very severe limitations that restrict the choice of plants, require very careful management, or both.

Class V. Soils subject to little or no erosion but have other limitations, impractical to remove, that

limit their use largely to pasture, range, woodland, or wildlife food and cover.

Class VI. Soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or wildlife food and cover.

Class VII. Soils have very severe limitations that make them unsuited to cultivation and that restrict their use largely to grazing, woodland, or wildlife.

Class VIII. Soils and landforms have limitations that preclude their use for commercial plant production and restrict their use to recreation, wildlife, or water supply, or to esthetic purposes.

CAPABILITY SUBCLASSES are soil groups within one class; they are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils, the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few limitations. Class V can contain, at the most, only subclasses indicated by *w*, *s*, and *c*, because the soils in it are subject to little or no erosion, though they have other limitations that restrict their use largely to pasture, range, woodland, wildlife, or recreation.

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe-3 or IIIe-5. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation, and the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraphs. The Arabic numeral specifically identifies the capability unit within each subclass. In the following pages the capability units in Red Willow County are described and suggestions for the use and management of the soils are given.

Capability unit I-1, dryland or irrigated

This unit consists of deep, well-drained, level or nearly level loams on bottom lands. These soils are easy to work and have an excellent supply of moisture for plant growth. There are no management problems, and yields are high. The water table is within 10 to 15 feet of the surface. The soils are—

Glenberg loam.
McCook and Haverson loams.

These soils are suited to corn, sorghum, alfalfa, wheat, and grass. They can be cultivated intensively without the use of special practices for control of runoff or erosion. Wind erosion is a problem in dry years if the soils lack a protective cover. Ordinary good cropping practices are needed. Legumes and green-manure crops are needed in the cropping system for maintaining high fertility and good soil structure. These soils respond readily if fertilizer is applied.

Soils in this unit are well suited to irrigation, since they absorb water quickly and release it to plants readily. In nearly all places land leveling is necessary for the best use of irrigation water. The time of applying water, the amount of water applied, and even distribution of the water are as important as the plant population and fertility in maintaining high yields. Nitrogen and phosphate fertilizers and a small amount of iron or zinc are needed for high yields. Applying large amounts of organic matter and barnyard manure improves soil structure.

Capability unit IIe-1, dryland or irrigated

In this unit are deep, very gently sloping silt loams. These soils are in the uplands and on colluvial fans and terraces. They are easy to work and have a good supply of moisture for plant growth. Water erosion is the main problem in cultivated areas, and the hazard of erosion is slight to moderate. The soils are—

Bridgeport silt loam, 1 to 3 percent slopes.
Holdrege and Keith silt loams, 1 to 3 percent slopes.
Holdrege and Keith silt loams, 1 to 3 percent slopes, eroded.
Hord silt loam, terrace, 1 to 3 percent slopes.

These soils are suited to wheat, sorghum, corn, and grass, but wheat is the major crop. Stripcropping, stubble-mulch tillage, and terracing help to conserve moisture and control erosion.

Most terraces in the county are on soils of this unit. The terraces are mostly level and hold water in V-shaped channels. Also used are some level terraces that have a flat channel. Level terraces that have a flat channel distribute rainwater that is retained (fig. 12) better than in those terraces that have V-shaped channels.

Emergency tillage and cover crops are needed when crops fail. Summer fallow is commonly used on these soils. Nitrogen and phosphate fertilizers are generally not required. Soil tests, however, may indicate that they are needed in some dryfarmed areas, especially on the Bridgeport soil.

If suitable methods are used for control of water erosion, these soils are well suited to irrigation. Corn, sorghum, and alfalfa are the crops best suited. Contour bench leveling (fig. 13), contour furrows, or other practices are needed for management of irrigation water and for control of erosion. Contour bench leveling is a particularly suitable practice to use, especially on the Bridgeport soil. If sprinkler irrigation is used, terraces and contour planting are needed. Fertility should be kept high, and water must be applied at the proper time. Corn grown on these soils may respond to zinc.

Capability unit IIe-3, dryland or irrigated

This unit consists of deep, nearly level fine sandy loams. These soils are on bottom lands and colluvial foot slopes. These soils are more subject to wind erosion than to water erosion but are susceptible to both. The soils are—

Bayard fine sandy loam, 0 to 1 percent slopes.
Glenberg fine sandy loam.
Haverson fine sandy loam.

Figure 12.—**Flat-channel terraces hold runoff and help to control erosion.**

The soils in this unit are suited to corn, alfalfa, wheat, and grass. Row crops should not be grown more than 2 years in succession. Stripcropping, shelterbelts, cover crops, and stubble-mulch tillage are needed for the control of water erosion and soil blowing.

These soils are well suited to irrigation. Soil blowing is a moderate hazard, and management of irrigation water is also a problem on the soils that are more sloping. High yields can be obtained by applying water at the proper time and in the correct amount and by growing an adequate number of plants per acre.

A suitable cropping system would consist of crops that provide a protective cover most of the year, especially in fall and winter. Cover crops are needed to protect the soils from blowing, and they are especially needed in areas that have been leveled.

Where these soils retain their fertility, they produce residues that protect them from blowing. In some dryfarmed areas, however, these soils have lost organic matter and fine soil material through blowing. In such areas adding stubble and other crop residues helps to increase the supply of organic matter. The response to nitrogen, phosphate, and zinc is better if these soils are irrigated than if they are dryfarmed.

Capability unit IIw-3, dryland or irrigated

McCook loam, overflow, is the only soil in this unit. It is a deep, highly productive soil that is subject to occasional flooding. This soil is on bottom lands along Beaver Creek and on the sides of narrow, level drainageways and creeks that flow into major streams throughout the county. On an average, this soil is flooded twice a year. Flooding often occurs early in spring before crops are planted, and thus moisture is stored in the soil. If flooding occurs during the growing season, however, damage to crops is slight to severe.

This soil is among the most productive in the county for irrigation. It would be the most productive soil in the county if flooding were controlled. Sorghum, corn, alfalfa, and grass are the crops best suited. Nitrogen and phosphate fertilizers and iron and zinc need to be applied in amounts indicated by soil tests.

Capability unit IIw-4, dryland or irrigated

This unit consists of nearly level, deep, imperfectly drained, loamy soils on bottom lands along the Republican River. These soils are highly productive. Yields are sometimes reduced, however, when the water table is high. The water table is generally at a depth of 2 to 6 feet and in many places benefits crops in dry years, because it sub-

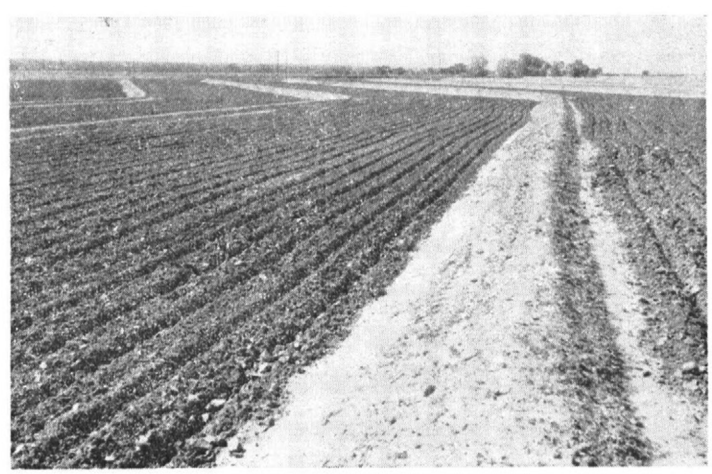


Figure 13.—**Contour bench leveling on Bridgeport silt loam, 1 to 3 percent slopes. The crop is to be irrigated.**

irrigates the soils and therefore helps produce high yields. The soils are—

Bayard loam, slightly wet.
Las loam.

The soils in this unit are suited to alfalfa, wheat, corn, sorghum, and grass. Wetness is the main problem in some seasons.

These soils are suited to irrigation, and erosion is seldom a problem. Leveling is needed in places to remove excess water and to keep the crops from drowning. Nitrogen fertilizer is needed for high yields and to maintain fertility. Phosphate fertilizer helps increase yields of legumes, and in places applying zinc increases yields of corn.

Capability unit IIw-6, dryland or irrigated

Glenberg fine sandy loam, slightly wet, is the only soil in this unit. It is a deep, nearly level, imperfectly drained, moderately sandy soil on bottom lands along the Republican River. The surface soil is loam to fine sandy loam. Below is fine sandy loam underlain by sand and gravel from the river. The water table is generally at a depth of 2 to 6 feet.

This soil is likely to be wet early in spring and in rainy seasons and is also subject to blowing when dry. Yields of alfalfa, small grain, sorghum, and corn are moderate, but in some years the water table is high enough to reduce yields.

This soil is suited to irrigation. Water is fairly easy to apply because the soil is nearly level and absorbs water readily. In places drainage is needed to remove excess water. Lack of fertility limits growth of crops. Alfalfa, however, responds if a moderate amount of phosphate is applied.

Capability unit IIc-1, dryland; I-1, irrigated

In this unit are deep, well-drained, level or nearly level silt loams that are easy to work. These soils are in the uplands, on terraces, and in areas of alluvium and colluvium. Their supply of moisture for plant growth is good. If the soils were located where there is more rainfall each year, they would be in capability class I. Erosion is a minor problem, and yields are good. The soils are—

Bridgeport silt loam, 0 to 1 percent slopes.
Holdrege and Keith silt loams, 0 to 1 percent slopes.
Hord silt loam, 0 to 1 percent slopes.
Hord silt loam, terrace, 0 to 1 percent slopes.

These soils are suited to wheat, corn, sorghum, and grass, but wheat is the major crop. A wheat-summer fallow system is suitable. Fertility is generally high, but soil tests indicate that nitrogen or phosphate is needed in some areas. Conserving moisture is the principal management problem.

These soils are among the most productive in the county under irrigation, since they are nearly level and absorb water quickly and release it readily to plants (fig. 14). If irrigated, these soils are suited mainly to corn, sorghum, and alfalfa. Larger amounts of fertilizer are required for maintaining high yields than are needed under dryland farming. If large amounts of fertilizer are continuously used and high yields are maintained, these soils are likely to become deficient in some trace elements and require application of fertilizers that contain these elements. Growing legumes helps improve soil tilth and the rate of water intake. These soils need leveling so that irrigation water can be applied effectively.

Capability unit IIIe-1, dryland or irrigated

This unit consists of deep, gently sloping silt loams on uplands and on colluvial foot slopes. These soils are easy to work but are subject to slight to moderate erosion. The soils are—

Bridgeport silt loam, 3 to 6 percent slopes.
Holdrege and Keith silt loams, 3 to 6 percent slopes.
Holdrege and Keith silt loams, 3 to 6 percent slopes, eroded.
Ulysses silt loam, 3 to 6 percent slopes, eroded.

These soils are suited to wheat, corn, sorghum, and grass. If they are cultivated, the main hazard is moderate water erosion. Gullies are likely to form during hard rainstorms. The soils are also subject to blowing if they are left without a protective cover. Contour stripcropping, stubble-mulch tillage, and terracing help control erosion and conserve moisture.

Row crops should not be grown on these soils more than 2 years in succession. In places cover crops and emergency tillage are needed in dry years or in years when crops fail. Nitrogen and phosphate fertilizers are generally not needed in dryfarmed areas, but soil tests indicate they are needed in some places, especially on the Bridgeport soil.

If suitable methods are applied for control of water erosion, these soils are well suited to irrigation. Corn, sorghum, and alfalfa are the crops best suited. Contour bench leveling, contour furrows, or other practices are needed for management of irrigation water and for control of erosion. Contour bench leveling is a particularly suitable practice to use, especially on the Bridgeport soil. If sprinkler irrigation is used, terraces and contour planting are needed. Fertility should be kept high, and water must be applied at the proper time. Corn grown on these soils may respond to zinc.

Capability unit IIIe-3, dryland; IIe-3, irrigated

The only soil in this unit is Bayard fine sandy loam, 1 to 3 percent slopes. It is a deep, very gently sloping, moderately sandy soil on terraces or in colluvial or alluvial areas. This soil is predominately fine sandy loam throughout. The main problem is soil blowing.

Figure 14.—Irrigated sorghum on Holdrege and Keith silt loams, 0 to 1 percent slopes.

This soil is suited to corn, alfalfa, wheat, and grass. Row crops can be grown 1 or 2 years in succession. Stripcropping, shelterbelts, cover crops, and stubble-mulch tillage are some of the practices needed for control of soil blowing and water erosion and to keep the soil productive. Fertilizer is needed for improved yields.

The soil is well suited to irrigation, but management of irrigation water is a problem on the more sloping areas. High yields can be obtained by applying water at the proper time and in the correct amount and by growing an adequate number of plants per acre.

A suitable cropping system would consist of crops that provide a protective cover most of the year, especially in fall and winter. Cover crops are needed to protect the soils, and they are especially needed in areas that have been leveled.

Where this soil retains its fertility, it generally produces residues that protect it from blowing. In some dryfarmed areas, however, the soil has lost organic matter and fine soil material through blowing. In such areas the practice of working stubble and other crop residues into the soils helps to increase the supply of organic matter. The response to nitrogen, phosphate, and zinc is better in irrigated areas than in dryfarmed areas.

Capability unit IIIe-5, dryland or irrigated

Bankard loamy fine sand is the only soil in this unit. It is a deep, nearly level or very gently sloping soil that occupies somewhat low, hummocky areas on bottom lands along the Republican River. The subsurface layer generally is fine sand. Productivity is low to moderate. This soil absorbs water rapidly, but it has low capacity to hold water in the root zone.

Corn, sorghum, and grass are the crops best suited to this soil. The soil is subject to severe blowing, and stripcropping, cover crops, shelterbelts, and stubble-mulch tillage are needed for control of erosion.

Intensive management is needed in irrigated areas because the surface and subsurface layers are very sandy. The rate of water intake is very high, and short irrigation runs are therefore needed. This soil stores little water or plant nutrients in the root zone, and nitrogen and phosphate fertilizers are consequently required.

Capability unit IVe-1, dryland or irrigated

This unit consists of deep, gently sloping to moderately sloping silt loams that are easy to work. Slopes generally range from 6 to 9 percent, but in pastured areas they are as much as 12 percent. Water erosion is moderate to severe in cultivated areas (fig. 15), and here lime is at or near the surface. These soils are low in organic matter and nitrogen. Yields are also low. The soils are—

Ulysses silt loam, 6 to 9 percent slopes.
Ulysses silt loam, 6 to 9 percent slopes, eroded.

These soils are suited to wheat, corn, sorghum, and grass. They are also suited to summer fallow, and native grasses are well suited. Because of the severe hazard of water erosion, grasses and legumes ought to be grown at least half of the time. A row crop can be grown 1 year in 5, but close-growing crops provide more protection from erosion. Suitable cropping systems and tillage practices help conserve moisture. Stubble-mulch tillage, fertilizer, and terraces are needed for improved productivity and control of erosion. Terraces can be constructed if the terrain is suitable.

Figure 15.—**An area of Ulysses silt loam, 6 to 9 percent slopes, eroded. This soil washes unless carefully managed.**

These soils are suited to sprinkler irrigation, and alfalfa or grass crops are best suited. Yields can be increased if phosphate fertilizer is applied.

Capability unit IVe-8, dryland

The only soil in this unit is Colby silt loam, 3 to 9 percent slopes. This deep, gently sloping to moderately sloping soil is severely eroded. Most of the acreage is on slopes of about 6 percent on the edges of fields above strongly sloping areas that are pastured. The content of organic matter is very low, and the soil erodes quite easily.

This soil is marginal for crops. Terracing, contour farming, and similar conservation practices on this soil and on the soils above it help to reduce runoff. Most areas of this soil should be reseeded to native grasses and eventually pastured. If the soil is cultivated, row crops should be grown less than one-fourth of the time, and hay or pasture crops about one-half of the time. Use of crop residues and stubble-mulch tillage help to cover the soil and thus reduce erosion.

Capability unit IVw-5, dryland; IIIw-5, irrigated

The only soil in this unit is Las sand, overwash. It is a sand-covered, silty soil in low, hummocky areas; it is wet in places because of a moderately high water table. This soil consists of 1 to 2 feet of fine sand overlying silty material. Slopes range from 0 to 3 percent, and the surface is uneven. Yields are moderately high because plant roots are able to move down into the silty material.

This soil is best suited to corn, sorghum, and grass, but care must be taken to control wind erosion. Cover crops, stripcropping, shelterbelts, and stubble-mulch tillage are needed for maintaining yields and controlling soil blowing.

This soil is suited to irrigation. Wetness and manage-

ment of water are the main limitations. The soil blows during droughts, and it is low in fertility. Cover crops and catch crops help to keep the soil from blowing. Crops may drown out during wet seasons. The time of applying water, the amount of water applied, and even distribution of the water are important practices. Alfalfa responds if fertilizer that contains phosphate is added.

Capability unit IVs-1, dryland; IIIs-1, irrigated

This unit consists of nearly level, deep to moderately deep soils that are moderately alkaline. These soils are on bottom lands and terraces along the Republican River. The surface layer is silt loam, fine sandy loam, or loam. The soils are—

Hord-slickspot complex.
Las loam, saline-alkali.

Alkaline areas cover less than half of the total area of this unit. The soils have a high water table, and salt is transported upward through the profile by capillary action. When the water table recedes, moisture evaporates, and salt accumulates and in many places leaves a white crust on the surface. Generally, the water table is at a depth of 2 to 6 feet.

Areas not affected by the alkali make up more than half the total area. Productivity is generally good, but it is lower in years when the water table is high. Yields on the alkaline areas range from fair to poor, depending on the way that alkali salts and moisture affect the soils.

Corn, sorghum, alfalfa, and grass are suitable crops. Alfalfa and some grasses are more tolerant of alkali than other suitable crops and are therefore desirable in areas that are severely affected by alkali. In some alkaline areas drainage practices and chemical treatment are desirable.

Crops suited to these soils are limited, and available phosphorus for all crops suitable is lacking in these soils. Corn needs applications of zinc, and sugarbeets, barley, and corn may need nitrogen. Unless the water table remains at least 3 feet or more below the surface and special crops are grown, applying a large amount of sulfur and other soil amendments is not feasible. Sulfur or other soil amendments can be used periodically if large amounts of salt and sodium are in the irrigation water. Applying soil amendments, however, is not a substitute for proper management. Soil amendments are not effective unless enough water is applied, the water is distributed evenly, and a suitable cropping system is used. A suitable cropping system includes legumes.

Capability unit Vw-1, dryland

The only soil in this unit is Barney silty clay loam. It is a poorly drained, shallow soil on bottom lands along the Republican River. The areas formerly were part of the river channel. This soil consists of 6 to 12 inches of silt loam or silty clay loam underlain by sand and gravel from the river.

The water table is at or near the surface most of the time, and this soil is therefore too wet for cultivation. Drainage is not feasible. The areas are consequently used for native hay and pasture and for food and cover for wildlife.

Capability unit VIe-5, dryland

The only soil in this unit is Bankard fine sand. It is a nearly level or very gently sloping, deep soil on low hummocks on bottom lands along the Republican River. The soil material is fine sand and overlies sand and gravel from the river. The surface is uneven.

This soil is subject to erosion. It is not suited to cultivated crops but can be cultivated enough to establish cover crops, grass, or trees. If this soil is well managed, yields of pasture are high.

Seeding adapted grasses in cultivated areas and in pastures where the stand of grass is poor helps to control wind erosion and to conserve moisture.

Capability unit VIe-9, dryland

Colby silt loam, 9 to 30 percent slopes, is the only soil in this unit. It is a deep, strongly sloping soil of the uplands. The surface soil is thin. Water enters the soil readily, but runoff is rapid because the slopes range from 9 to 30 percent.

This soil is better suited to native grass than to cultivated crops. Native grass should be reseeded in cultivated areas. Cover crops are needed to help establish native grass, and management that includes rotation grazing and proper degree of grazing is also needed.

Many sites on these soils are suitable for stockwater dams, grade-control structures, and flood-detention reservoirs. These structures help to control erosion and conserve moisture and can be used as recreational facilities.

Capability unit VIw-1, dryland

Broken alluvial land is the only land type in this unit. It is on bottom lands along creeks in the county. The areas are cut by deep, narrow drainageways, and some are flooded frequently. Abrupt slopes and uneven terrain between the drainageways are characteristic of the areas.

Areas of this land type are difficult to work or are too narrow or flooded too frequently for cultivation. A few small areas away from the meandering drainageways are smooth enough for cultivation, but small plants on them are washed out or covered by floods in most years. This land type can be cultivated enough to establish cover crops, grass, or trees.

Capability unit VIw-5, dryland

This unit consists of Sandy alluvial land, which is made up mostly of deposits laid down by floodwaters. The deposits are deep and are mostly fine sand that contains thin, stratified layers of finer material. The areas are only on bottom lands along the Republican River. The surface is quite irregular because of channels or hummocks left by the floods. The water table is moderately high.

Most of this land type is covered by sparse to fairly dense stands of trees that grew up after the flood of 1935. In areas where the tree stand is thin, native grasses are present. The wooded and brushy areas provide little grazing but are excellent habitats for squirrel, deer, rabbit, pheasant, and quail.

Capability unit VIIe-1, dryland

Rough broken land, loess, is the only land type in this unit. It consists of deep, silty material in steep canyons or on bluffs.

The suitability of this land type for grazing or for trees is limited. Slopes on the sides of canyons are steep. As a result, the soil has moved downward in landslips, locally known as catsteps. In many places runoff water from the

sides of the canyons has caused deep gullies to form in the canyon floors.

Management that maintains a good cover of grass helps to control runoff, reduce erosion, and conserve moisture. It also produces the most suitable forage for grazing.

Many areas of this land type provide suitable sites for stockwater dams, for grade-control structures, and for flood-detention reservoirs.

Capability unit VIIs-3, dryland

Rough broken land, caliche, is the only land type in this unit. It is made up of soil material that is very shallow to moderately deep over bedrock or gravel.

Use of this land type for grazing is limited. The areas are also too steep and rocky for cultivated crops.

Controlled grazing and other range management practices are needed for maintaining a good cover of grass. Growing a good stand of grass in the cracks or crevices between exposures of rock and in the soil areas around them is the only effective way of controlling runoff and conserving moisture. Stockwater dams to provide water for livestock, grade-control structures, and flood-detention reservoirs can be constructed, but care must be taken in selecting the site and in designing and building the structure.

Predicted Yields

Predicted average acre yields of the principal crops on the soils of the county are given in table 2. These predictions are based on average yields for the county obtained from the annual Nebraska Agricultural Statistics Report. They are also based on information obtained from farmers throughout the county and on observations made by agricultural workers and others who are familiar with the soils. The predictions are averages for a period of 10 years.

Predicted average yields per acre are given under two levels of management. In columns A are the yields to be

TABLE 2.—*Predicted average acre yields of principal crops*

[Yields in columns A are those predicted under common management; yields in columns B are those predicted under improved management; absence of yield indicates crop is not suited to the soil or is not commonly grown]

Soil	Corn				Alfalfa				Wheat		Grain sorghum		Forage sorghum	
	Irrigated		Dryland		Irrigated		Dryland							
	A	B	A	B	A	B	A	B	A	B	A	B	A	B
	Bu.	Bu.	Bu.	Bu.	Tons	Tons	Tons	Tons	Bu.	Bu.	Bu.	Bu.	Tons	Tons
Bankard fine sand														
Bankard loamy fine sand			12	18			1. 0	1. 25	8	15	14	19	1. 0	1. 5
Barney silty clay loam														
Bayard fine sandy loam, 0 to 1 percent slopes	70	90	20	30	4. 0	5. 0	2. 0	3. 0	18	24	20	26	1. 5	2. 0
Bayard fine sandy loam, 1 to 3 percent slopes	65	85	18	28	3. 0	4. 0	1. 5	2. 5	17	23	18	25	1. 25	1. 75
Bayard loam, slightly wet	70	80	23	33	5. 0	6. 0	3. 0	3. 5	20	25	25	32	2. 25	3. 0
Bridgeport silt loam, 0 to 1 percent slopes	75	100	23	33	5. 0	6. 0	2. 5	3. 0	23	29	26	32	1. 5	2. 0
Bridgeport silt loam, 1 to 3 percent slopes	75	95	21	31	4. 25	5. 25	2. 0	2. 5	22	28	24	30	1. 25	1. 75
Bridgeport silt loam, 3 to 6 percent slopes	55	90	12	16	3. 5	5. 0	1. 0	1. 5	18	25	20	27	1. 0	1. 5
Broken alluvial land														
Colby silt loam, 3 to 9 percent slopes			4	6				. 5	8	12	6	10	. 5	1. 0
Colby silt loam, 9 to 30 percent slopes														
Glenberg fine sandy loam	60	80	18	23	4. 5	5. 5	2. 0	2. 5	18	23	22	23	2. 0	2. 5
Glenberg fine sandy loam, slightly wet	58	78	19	24	4. 5	5. 5	2. 0	2. 5	16	21	21	31	1. 75	2. 25
Glenberg loam	75	95	25	35	5. 0	6. 0	3. 0	3. 5	21	26	27	35	2. 5	3. 0
Haverson fine sandy loam	70	95	20	25	4. 5	5. 5	2. 5	3. 0	20	28	25	35	2. 75	3. 25
Holdrege and Keith silt loams, 0 to 1 percent slopes	75	95	21	26	5. 0	6. 0	1. 0	2. 0	23	29	27	31	1. 25	1. 75
Holdrege and Keith silt loams, 1 to 3 percent slopes	75	95	20	25	4. 25	5. 5	1. 0	1. 5	22	28	25	30	1. 5	2. 0
Holdrege and Keith silt loams, 1 to 3 percent slopes, eroded	70	90	18	24	4. 0	5. 0	. 75	1. 0	21	28	25	30	1. 25	1. 5
Holdrege and Keith silt loams, 3 to 6 percent slopes	60	80	14	18	3. 25	4. 5	. 75	1. 0	18	26	20	28	1. 0	1. 25
Holdrege and Keith silt loams, 3 to 6 percent slopes, eroded	55	80	12	16	3. 0	4. 0	. 5	1. 0	17	25	21	28	1. 0	1. 25
Hord silt loam, 0 to 1 percent slopes	75	95	22	27	5. 0	6. 0	1. 0	1. 5	24	30	28	32	1. 5	2. 0
Hord silt loam, terrace, 0 to 1 percent slopes	75	100	23	33	5. 0	6. 0	2. 5	3. 0	24	30	30	38	2. 0	2. 5
Hord silt loam, terrace, 1 to 3 percent slopes	75	95	22	31	4. 25	5. 5	2. 0	2. 75	23	28	28	35	1. 5	2. 0
Hord-slickspot complex	55	70	17	22	3. 0	4. 0	2. 5	3. 0	17	23	19	26	2. 5	3. 5
Las loam	70	90	24	34	3. 0	3. 75	2. 5	3. 0	18	24	22	30	2. 75	3. 0
Las loam, saline-alkali	45	60	12	17	2. 0	3. 0	1. 5	2. 0	9	12	11	15	1. 4	1. 5
Las sand, overwash			20	25			. 5	1. 0	7	13	12	16	1. 0	1. 5
McCook loam, overflow	70	95	40	50	5. 0	6. 0	3. 0	3. 5	18	29	34	42	3. 0	3. 25
McCook and Haverson loams	75	95	25	35	5. 0	6. 0	3. 0	3. 5	23	29	30	38	3. 0	3. 25
Rough broken land, caliche														
Rough broken land, loess														
Sandy alluvial land														
Ulysses silt loam, 3 to 6 percent slopes, eroded	55	80	13	16	3. 0	4. 0	. 5	1. 5	15	24	20	27	1. 0	1. 25
Ulysses silt loam, 6 to 9 percent slopes			10	12			. 25	1. 0	12	16	18	20	. 75	1. 0
Ulysses silt loam, 6 to 9 percent slopes, eroded			8	10			. 25	1. 0	10	15	16	20	. 75	1. 0

expected under common management, or the prevailing management, in the county. Yields in columns B are those to be expected under an improved system of management. To obtain the yields in columns B, management is needed that includes: (1) Use of conservation practices; (2) use of cropping systems; (3) use of fertilizer in amounts indicated by soil tests; and (4) returning crop residues to the soil.

The predictions in both columns are current. Marked change in weather, use of new varieties of crops, and other factors could cause changes in yields.

Managing Rangeland [1]

The original vegetation in Red Willow County was mainly grasses and forbs. The county is part of an area that is subject to alternate periods of drought and abundant rainfall. The kinds of plants that survived therefore were those that could adjust to such extremes of climate.

After settlement the steeply sloping areas on breaks along the Republican River and its tributaries were left in native plants. Much of the rest of the acreage in the county was plowed and farmed. In recent years, however, farming has been discontinued on the more sloping soils.

About 36 percent of the acreage in the county is now in grass used for hay or pasture for cattle, sheep, and horses. In 1959, according to the U.S. Census of Agriculture, income from the sale of livestock and livestock products in the county accounted for 57 percent of the total agricultural income. Herds of beef cows are the main enterprise, but the raising of yearlings is increasing.

The primary requirement for good range management in this county is conserving the cover of grass. In this way losses of soil and water are reduced, yields maintained, and deposition of silt in streams, waterways, and reservoirs prevented.

The purpose of this section is to help ranchers in planning the management of their range. It describes the range sites in the county, explains how range condition classes are appraised, provides estimated yields for range sites, and discusses practices that will improve yields from rangeland.

Range sites and range condition

The rancher or livestock farmer needs to know the soils and vegetation on his holdings so that he can identify the kinds and combinations of native plants that represent climax vegetation on each site. He also needs to be able to recognize changes in the plant cover that indicate whether his range is getting better or worse.

A *range site* is an area of natural grazing land sufficiently uniform in climate, soils, and topography to produce a particular climax, or original, vegetation. It retains its ability to reproduce such plant cover so long as the environment remains unchanged. Because the combination of climate, soils, and topography differs from one range site to another, a given site needs management different from that of other sites if the desirable plants are to be maintained or improved.

The original, or *climax*, vegetation is the combination of plants that grew on the range site before the plant cover was altered by intensive grazing or by plowing. It is the combination of forage plants that is most productive and that will persist without the aid of tillage, fertilizer, and replanting.

Under prolonged heavy grazing, range plants react in different ways. Some kinds of plants decrease, some increase, and others originally not present may invade. *Decreasers* are plants of the original community that decrease in amount of herbage they contribute to the total cover if they are closely and continuously grazed. *Increasers* are plants of the original cover that normally increase, at least for a time, in the relative amount of total herbage they produce. They increase as the decreasers cover less of the site. *Invaders* are plants not in the original plant community that start growing in an area after the decreasers and increasers have been weakened or eliminated. A rancher tries to manage his range so that it has a large amount of decreasers and fewer increasers or invaders, for then he keeps his range in desirable condition.

The condition of the range is determined by comparing the kind and vigor of the plants now growing in an area with the plants that originally grew there. In making this comparison the rancher estimates the percentage of the present vegetation made up of plants that grew in the climax vegetation. Condition classes based on this percentage have been established (*3*).[2] A range is in *excellent condition* if 76 to 100 percent of the vegetation is of the same kind as the original stand. It is in *good condition* if the percentage is 51 to 75, in *fair condition* if the percentage is 26 to 50, and in *poor condition* if the percentage is less than 25.

As range condition deteriorates under close grazing, the same area of land is successively occupied by many kinds of plants in many combinations. The changes take place gradually and commonly are not recognized until the desirable forage plants are seriously weakened or destroyed. On a range that is well managed, the improvements are also a gradual process.

For this reason, the rancher needs to know the condition of his range and whether it is deteriorating or improving. He wants to keep his range in excellent or good condition because such range produces the most yield and has the best cover of plants for conserving moisture and protecting the soils.

Surveys showing the range sites and condition classes on a ranch give the operator an inventory of both present and potential grazing resources. They show areas that are producing below their potential and those that are producing at their potential. In this way they help the rancher plan a grazing program that improves or maintains his range. Assistance in planning such surveys can be obtained from local representatives of the Soil Conservation Service and other agencies of the U.S. Department of Agriculture.

To aid the rancher in managing rangeland, the soils of the county have been grouped in 10 range sites. These are described in the pages that follow in order of decreasing productivity of the sites.

[1] LORENZ F. BREDEMEIR, range conservationist, Soil Conservation Service.

[2] Italic numbers in parentheses refer to Literature Cited, p. 49.

WETLAND RANGE SITE

Only one mapping unit—Barney silty clay loam—is in this range site. It is a marshy and subirrigated soil in low-lying areas in former channels of the Republican River. The channels are only 2 to 4 feet above the normal streamflow, and consequently, the water table is above the surface during part of the growing season.

This site is the most productive range site in the county. The climax vegetation on this site is prairie cordgrass, tall sedges, and reedgrasses, which are all decreasers. Increasers include a small amount of mid sedges and rushes. Willows and all annuals are the main invaders.

SUBIRRIGATED RANGE SITE

This range site consists of areas that are mainly on bottom lands of the Republican River. The water table is close enough to the surface to affect plant growth. It fluctuates during the growing season, but most of the time it is within reach of plant roots, and it rarely rises above the surface. The soils in this site are—

Bayard loam, slightly wet.
Glenberg fine sandy loam, slightly wet.
Las loam.
Las sand, overwash.
Sandy alluvial land.

This site is among the most productive in the county. Big bluestem, switchgrass, and indiangrass are decreasers that make up the climax vegetation. They produce 70 to 90 percent of the herbage on these areas. Increasers on this site are western wheatgrass, tall dropseed, plains bluegrass, scouringrush, and sedges. Invaders include Kentucky bluegrass, willows, cottonwoods, and cedars.

SALINE SUBIRRIGATED RANGE SITE

Las loam, saline-alkali, is the only soil in this range site. It consists of a small acreage along the bottom lands of the Republican River. The water table is close enough to the surface to affect plant growth and make the soil strongly saline and alkaline. The water table fluctuates during the growing season but is generally within reach of plant roots and rarely rises above the surface.

This site is among the most productive in the county. Switchgrass, indiangrass, western wheatgrass, and alkali sacaton are decreasers on this site and are also the climax grasses that produce 75 to 90 percent of the herbage. Inland saltgrass is the principal increaser. Invaders include willows, cedars, and Kentucky bluegrass.

OVERFLOW RANGE SITE

This range site consists of areas in the Beaver Creek valley and along large drainageways leading to the Republican River. These areas receive above average soil moisture because of excess water from higher areas and from stream overflow. The soils in this site are—

Broken alluvial land.
McCook loam, overflow.

On this site the climax vegetation is big bluestem, western wheatgrass, and switchgrass. In some places little bluestem, slender wheatgrass, and prairie cordgrass make up a large amount of the stand. The decreasers are big bluestem, little bluestem, switchgrass, and prairie cordgrass. The increasers are western wheatgrass, blue grama, sand dropseed, and short sedges. The invaders are buffalograss, western ragweed, biennial sagewort, and annuals.

SANDS RANGE SITE

This range site consists of deep, loose fine sand or loamy fine sand on nearly level to very gently sloping ridges or hummocks along the Republican River. The soils in this range site were deposited by numerous floods. The soils are—

Bankard fine sand.
Bankard loamy fine sand.

The vegetation here is not that which originally grew, because this site contains areas recently disturbed by floods. The potential climax vegetation is switchgrass, prairie sandreed, indiangrass, big bluestem, sand bluestem, Canada wildrye, and little bluestem, all of which are decreasers except prairie sandreed and little bluestem. The main increasers are these two grasses, plus sand dropseed, blue grama, and Scribner panicum. The most common invaders are biennial sagewort, curlycup gumweed, sand paspalum, and annuals.

SANDY RANGE SITE

In this range site are fine sandy loams that are on bottom lands and colluvial fans and slopes along the Republican River. The soils in this site are—

Bayard fine sandy loam, 0 to 1 percent slopes.
Bayard fine sandy loam, 1 to 3 percent slopes.
Glenberg fine sandy loam.
Haverson fine sandy loam.

Big bluestem, switchgrass, indiangrass, prairie sandreed, western wheatgrass, and Canada wildrye make up the principal part of the climax vegetation. They produce 60 to 90 percent of the total herbage and grow in various combinations. All the climax grasses but western wheatgrass are decreasers. Needle-and-thread, western wheatgrass, tall dropseed, sand dropseed, and blue grama are the main increasers. Western ragweed, curlycup gumweed, sand paspalum, red three-awn, biennial sagewort, and annuals are the common invaders.

SILTY RANGE SITE

This range site is made up of deep loams and silt loams on nearly level to gently sloping bottom lands, colluvial slopes, terraces, and uplands throughout the county. Most areas of this range site are cultivated, and the rest of the site consists of small areas throughout the county. Nevertheless, this is the most extensive range site in the county. The soils in this site are—

Bridgeport silt loam, 0 to 1 percent slopes.
Bridgeport silt loam, 1 to 3 percent slopes.
Bridgeport silt loam, 3 to 6 percent slopes.
Glenberg loam.
Holdrege and Keith silt loams, 0 to 1 percent slopes.
Holdrege and Keith silt loams, 1 to 3 percent slopes.
Holdrege and Keith silt loams, 1 to 3 percent slopes, eroded.
Holdrege and Keith silt loams, 3 to 6 percent slopes.
Holdrege and Keith silt loams, 3 to 6 percent slopes, eroded.
Hord silt loam, 0 to 1 percent slopes.
Hord silt loam, terrace, 0 to 1 percent slopes.
Hord silt loam, terrace, 1 to 3 percent slopes.
Hord-slickspot complex.
McCook and Haverson loams.
Ulysses silt loam, 6 to 9 percent slopes.

The principal climax vegetation on this site is western wheatgrass, sideoats grama, little bluestem, blue grama, needle-and-thread, and big bluestem. The decreasers on this site are big bluestem, little bluestem, and plains muhly. The increasers are western wheatgrass, blue grama, needle-and-thread, and sideoats grama. Buffalograss, red and

fendler three-awns, tumblegrass, sand dropseed, broom snakeweed, and all annuals are the invaders.

THIN SILTY RANGE SITE

This range site, among the most extensive sites in the county, consists of soils on sloping hills that have a smooth surface. The soils formed in deep, silty material. They are—

Colby silt loam, 3 to 9 percent slopes.
Colby silt loam, 9 to 30 percent slopes.
Ulysses silt loam, 3 to 6 percent slopes, eroded.
Ulysses silt loam, 6 to 9 percent slopes, eroded.

Sideoats grama, needle-and-thread, blue grama, and big and little bluestems make up the main part of the climax vegetation. Little bluestem, big bluestem, and plains muhly are decreasers. Increasers are western wheatgrass, sideoats grama, needle-and-thread, and blue grama. Buffalograss, red three-awn, tumblegrass, broom snakeweed, and annuals are the main invaders.

THIN LOESS RANGE SITE

Rough broken land, loess, is the only soil in this range site. It consists of steeply sloping areas adjacent to streams. Catsteps occur in many of the areas. Slopes are generally 30 percent or more. The soils formed in material from loess, and they have a thin surface layer.

On this site the climax vegetation is mainly little bluestem, big bluestem, sideoats grama, plains muhly, needle-and-thread, and western wheatgrass. Plains muhly, little bluestem, and big bluestem are the decreasers. Sideoats grama, needle-and-thread, and western wheatgrass are the principal producers of forage, and they produce a small amount of increasers. Other increasers that make up a small amount of the climax vegetation are the blue grama and hairy grama. Areas without cover enlarge greatly as range condition declines. Red and fendler three-awns, prairie sunflower, and other annuals are the main invaders.

THIN BREAKS RANGE SITE

Rough broken land, caliche, is the only soil in this range site. It is made up of outcrops of limestone and sandstone intermixed with material from loess. The soil is of various textures and depths. Slopes are irregular and range from 20 to 60 percent. Areas of this soil are small and are mainly along Red Willow, Coon, and Dry Creeks. Small, nearly barren areas are included.

The climax vegetation on this site consists of sideoats grama, little bluestem, needle-and-thread, and blue grama. It includes lesser amounts of upland sedges, western wheatgrass, and big bluestem. All the climax vegetation consists of decreasers, except for upland sedges and blue grama, which are increasers. In many places forbs that form mats grow on thin soil material over the bedrock. Common invaders are broom snakeweed, red and fendler three-awns, and annuals.

Herbage production

Listed below are the range sites of Red Willow County and estimates of herbage production for the sites when in excellent range condition. Included in estimates of the annual production of herbage is the growth of leaves and stems of all grasses and forbs and the leaves, flowers, fruits, and twigs of woody plants. Not included in this listing are increases in stem diameter of trees and shrubs (bark and wood production).

Range site:	*Pounds of herbage produced on range in excellent condition*
Wetland	5,200–8,000
Subirrigated	2,800–5,400
Saline Subirrigated	2,300–4,800
Overflow	1,600–3,200
Sands	1,400–2,600
Sandy	1,300–2,700
Silty	1,200–2,800
Thin Silty	1,000–2,400
Thin Loess	800–2,000
Thin Breaks	800–2,000

Herbage production differs among the various range sites, and the amount of forage for a given site varies considerably from year to year. During a period of 25 years, the highest herbage yields may be as much as 10 times the lowest yields, but such fluctuations are not common.

Woodland and Windbreaks [3]

The native trees in Red Willow County grow only in the lowlands along the Republican River and its main tributaries and along Red Willow and Beaver Creeks. Cottonwoods grow in the low, wet areas. On the slightly drier and somewhat higher sites are American elm, green ash, hackberry, boxelder, and other wetland species. On the sandbars and along the margins of streams are a variety of willows. Native shrubs grow in widely scattered areas.

The trees growing in this county have little commercial value. Most of the stands have grown up in low-lying areas in the Republican Valley that had been in crops but were abandoned for that use after a severe flood in 1935. Flood-control devices now protect areas along the river, and it is likely that some of the wooded areas will be cleared and again used for crops.

This county is subject to extreme variations of weather, and parts of the county are nearly treeless. Consequently, windbreaks are much needed for protecting farmsteads and livestock. Most trees that are planted in the county are planted for the purpose of establishing windbreaks. The expense and labor involved in planting are more than offset by the many benefits to the rancher or farmer. Among the benefits are reduced cost of home heating; beautifying and protecting buildings, lots, and gardens; and control of snow drifting. Windbreaks also provide livestock shelter that helps to reduce feed costs and to improve habitats for songbirds and other wildlife.

Windbreak suitability groups

The soils of Red Willow County have been placed in six windbreak groups to help the rancher or farmer in establishing windbreak plantings. Each group is made up of soils that are suited to the same kinds of trees and that need similar management. The species are listed in order of suitability, based on present knowledge.

Two miscellaneous land types are too steep and shallow for planting of windbreaks and are not included in a windbreak suitability group. They are Rough broken land, caliche, and Rough broken land, loess. These soils are not suited to trees, and only native shrubs grow in a few scattered areas.

[3] G. W. ALLEY, woodland conservationist, Soil Conservation Service.

SILTY TO CLAYEY WINDBREAK GROUP

This windbreak group consists of deep, well-drained, silty or loamy soils that have a claypan. The soils in this group are—

Bridgeport silt loam, 0 to 1 percent slopes.
Bridgeport silt loam, 1 to 3 percent slopes.
Bridgeport silt loam, 3 to 6 percent slopes.
Colby silt loam, 3 to 9 percent slopes.
Colby silt loam, 9 to 30 percent slopes.
Glenberg loam.
Holdrege and Keith silt loams, 0 to 1 percent slopes.
Holdrege and Keith silt loams, 1 to 3 percent slopes.
Holdrege and Keith silt loams, 1 to 3 percent slopes, eroded.
Holdrege and Keith silt loams, 3 to 6 percent slopes.
Holdrege and Keith silt loams, 3 to 6 percent slopes, eroded.
Hord silt loam, 0 to 1 percent slopes.
Hord silt loam, terrace, 0 to 1 percent slopes.
Hord silt loam, terrace, 1 to 3 percent slopes.
McCook and Haverson loams.
Ulysses silt loam, 3 to 6 percent slopes, eroded.
Ulysses silt loam, 6 to 9 percent slopes.
Ulysses silt loam, 6 to 9 percent slopes, eroded.

These soils generally provide good sites for planting trees, especially for adapted species. Survival of planted trees on these soils is good. Droughts and the resulting competition for moisture from weeds are the main hazards. The gently sloping areas are also subject to erosion.

For good survival of seedlings on these soils, the sites must be well prepared. Clean cultivation is also needed, cover crops should be grown, and supplemental irrigation must be provided. The planting stock should be of good quality, the stock must be carefully handled so that the roots do not dry out, and planting must be carefully done.

Suitable conifers for windbreak plantings on the soils in this group are redcedar, ponderosa pine, Rocky Mountain juniper, Austrian pine, Scotch pine, and arbovitae. Honeylocust, hackberry, green ash, bur oak, American elm, and Siberian elm are suitable medium and tall broadleaf trees. Russian mulberry, boxelder, and Russian-olive are the only small broadleaf trees that are suited. Suitable shrubs for plantings are cotoneaster, honey suckle, lilac, Nemaha plum, American plum, chokecherry, and buffaloberry.

SLIGHTLY SANDY WINDBREAK GROUP

Nearly level, sandy soils and slightly sandy soils are in the Slightly Sandy windbreak group. The soils in this group are—

Bankard loamy fine sand.
Bayard fine sandy loam, 0 to 1 percent slopes.
Bayard fine sandy loam, 1 to 3 percent slopes.
Glenberg fine sandy loam.
Haverson fine sandy loam.

If soil blowing is controlled, the soils in this group are well suited to tree plantings. Maintaining strips of vegetation between the rows of trees and restricting cultivation to the rows help to control soil blowing. The hazards are similar to those for the soils in the Silty to Clayey windbreak group and the management practices needed are also similar.

Suitable conifers for windbreak plantings on soils in this group are redcedar, Rocky Mountain juniper, ponderosa pine, Austrian pine, and Scotch pine. Green ash, cottonwood, Siberian elm, and honeylocust are medium and tall broadleaf trees that are suitable. Russian mulberry and boxelder are the only small broadleaf trees that make suitable windbreak plantings. Suitable shrubs are western sand cherry, lilac, and American elm.

VERY SANDY WINDBREAK GROUP

Bankard fine sand is the only soil in the Very Sandy windbreak group. It is a loose-textured soil that is not suitable for cultivation. Trees must therefore be planted in a shallow furrow and no cultivating done. Suitable conifers for windbreak plantings are redcedar, Rocky Mountain juniper, and ponderosa pine. Broadleaf trees and shrubs are not suitable.

MODERATELY WET WINDBREAK GROUP

In this group are soils on bottom lands and in upland valleys that are sometimes wet because of flooding or a high water table, or that are subject to frequent floods of short duration. The soils in this group are—

Bayard loam, slightly wet.
Broken alluvial land.
Glenberg fine sandy loam, slightly wet.
Las loam.
Las sand, overwash.
McCook loam, overflow.
Sandy alluvial land.

These soils make good planting sites if the species selected can tolerate occasional periods of wetness. The only conifers suitable are redcedar and Austrian pine. Suitable medium and tall broadleaf species are honeylocust, green ash, cottonwood, golden willow, white willow, and Siberian elm. Small broadleaf trees that are suitable are Russian-olive, Russian mulberry, diamond willow, and boxelder. Red-osier dogwood, purple willow, buffaloberry, chokecherry, lilac, and American plum are shrubs that are suitable.

WET WINDBREAK GROUP

Barney silty clay loam is the only soil in the Wet windbreak group. This soil is in depressions in bottom lands that are extremely wet because of a high water table, flooding, or poor drainage. It is therefore suited only to trees that can tolerate wetness. Conifers are not considered suitable for this soil. Cottonwood and golden and white willows are suitable medium and tall broadleaf trees. Diamond willow is a suitable small broadleaf tree. Suitable shrubs are red-osier dogwood, purple willow, and buffaloberry.

MODERATELY SALINE-ALKALI WINDBREAK GROUP

This windbreak group consists of soils that are moderately saline or are alkaline. The soils in this group are—

Hord-slickspot, complex.
Las loam, saline-alkali.

The soils in this windbreak group are suitable only for trees that can tolerate moderate concentrations of salts or alkali. Redcedar is the only species of conifers suitable for planting on these soils. Siberian elm, green ash, honeylocust, and cottonwood are suitable medium and tall broadleaf trees. Suitable small broadleaf trees are diamond willow and Russian-olive. Tamarisk, three-leaved sumac, and buffaloberry are the only suitable shrubs.

Planting and care of windbreaks.—Establishing a good stand of trees in windbreak plantings in Red Willow County is difficult. Nevertheless, healthy seedlings of adapted species can be established if the seedlings are kept in good condition and are planted with care in a prepared site.

Sites that are in alfalfa or grass sod must be summer fallowed at least a year before the site is planted. A planting site that is in crops needs to be plowed in spring or fall. Disking just before planting keeps the soil in good tilth. Planting can be done by hand or by machine. The seedlings must be placed at the same depth that they were growing in the nursery bed. Leave enough room so that the roots can spread out, and press the soil firmly around the roots to prevent air pockets.

Young trees need to be cultivated until they are large enough to make a canopy that shades out weeds and grasses. Cultivation is generally needed for 4 to 6 years after the site is planted. Newly planted trees grow more rapidly, and more of them survive, if cultivation is confined to tree rows and if the strips between the rows are planted to corn, sorghum, or other tall cover crops. Such crops protect the plantings from strong winds and the hot sun. If irrigation water is available, applying large amounts in fall prevents winter winds from drying out the trees. The irrigation water also provides moisture needed for spring growth.

The rate at which trees in windbreak plantings grow varies considerably, according to the kinds of trees and the condition of the soil. The amount of moisture available in the soil is of prime importance. Soil fertility, exposure of the site to sun and wind, and arrangement of trees within the windbreak must also be considered. Some kinds of trees grow much faster than others. Also, some trees, for example, cottonwood, grow rapidly but do not live long. Tamarisk and Siberian elm grow rapidly but are undesirable in windbreaks because they tend to spread to adjacent areas and are likely to become serious pests. Both American elm and Russian-olive are poor risks for plantings because they are subject to Dutch elm or other serious diseases.

The most desirable conifers for windbreak plantings are ponderosa pine, Austrian pine, Rocky Mountain juniper, and redcedar, but many broadleaf trees and shrubs can also be used. Past experience shows that the windbreak that is effective over the longest period is the one that has the largest number of conifers. From 50 to 70 percent of the plantings must be redcedar, pine, or other kinds of conifers.

Redcedars grow about 1 foot per year, and at maturity they generally are as much as 30 to 40 feet tall. Normally, pines and broadleaf trees grow somewhat faster and are taller than cedars at maturity. Redcedars are generally best for most windbreak plantings because their foliage is thick, their growth is vigorous, and they are fairly free of insects and diseases. Their foliage is dense and close to the ground, which makes them excellent in the outside row of a windbreak. If the width of the windbreak is limited to a few rows, redcedar and pine are the trees to plant.

Designing windbreaks.—Windbreaks that are most effective in protecting farmsteads and feedlots in winter are those that are 5 to 10 rows wide. The width depends on the amount of space that is available. A windbreak that is 10 rows wide keeps most of the snow within the belt and is especially desirable for protection of livestock. Place the rows north and west of the area to be protected, and the outside rows not less than 100 feet from driveways and buildings. Care is needed in locating a windbreak to keep snow from accumulating on public roads.

The rows in a windbreak must be spaced at 12- to 16-foot intervals to provide the best protection for an area. Equipment used in cultivating must be considered in planning the spacing of the rows. Spacing of trees inside the rows varies, depending on the kind of trees and their arrangement within the belt. Space redcedars and shrubs in the outside rows 4 feet apart and conifers in the inside rows 6 feet apart. Broadleaf trees are generally spaced at intervals of 8 feet to make a good barrier.

The use of pre-emergent herbicide sprays, in place of cultivating the soil, for control of undesirable weeds and grasses is increasing. If properly applied in narrow bands around the trees at planting time, herbicide sprays hold back competing vegetation without damaging the trees. Since cultivation of a tree belt is often difficult because of the labor involved, the use of herbicides is a useful method of weed control.

Keeping livestock out of the windbreak is necessary if a good barrier is to be successfully maintained, regardless of the age of the trees. The trees also require protection from rodents, insects, and diseases. Assistance on problems regarding the establishment and care of windbreaks can be obtained from local representatives of the Soil Conservation Service and the county agent.

Managing Wildlife [4]

The soils of Red Willow County produce vegetation that provides suitable habitats for many kinds of wildlife. Deer are common throughout the county. Skunks, badgers, and other small mammals are numerous.

The ringneck pheasant is the most important game bird, but bobwhite quail are also found where suitable cover is available. Waterfowl are found along the Republican River, mainly during migrations in spring and fall. Hawks and owls are common predators.

Channel catfish and other kinds of fish are common in the Republican River. Sites suitable for developing pits and ponds for channel catfish, bass, and bluegill are in areas near the river. The Sandy alluvial land-Las-Glenberg soil association, for example, provides opportunities for developing areas for fishing.

Soils that are not suitable for cultivation or grazing generally are well suited to development for wildlife. Protecting the natural cover on such soils or establishing a suitable cover where needed helps to improve the areas for wildlife. Examples of areas that provide excellent habitats for wildlife and that are suitable for improvement are canyons and areas around the heads of canyons in the Colby soil association.

The wildlife resources of the county are important primarily for the recreational opportunities that they provide for hunting and fishing. Many species of wildlife, however, are also beneficial in control of undesirable rodents and insects.

Sites for development of recreational facilities are available in the county. These likely would be oriented toward fish and wildlife resources. Some soil areas, however, also are suitable as sites for camping grounds and picnic grounds. Technical assistance in planning development of areas for outdoor recreation, and suitable conservation practices for the sites, is available from the local office of the Soil Conservation Service.

[4] By CHARLES BOHART, biologist, Soil Conservation Service.

The potential of the soil associations in Red Willow County for producing habitats for the more important species of wildlife are given in table 3. Ratings of *very good*, *good*, and *fair* in the table take into account the kinds of soils in each association and their potential (shown in the column titled "Food") for producing the kind of vegetation needed for the various habitats. For more detailed information about the soil associations refer to the section "General Soil Map," and then turn to the section "Descriptions of the Soils" for further information about each soil.

Development of specific habitats for wildlife requires proper location and distribution of the kind of vegetation that the soils can produce. Technical assistance in planning wildlife developments and determining which species of vegetation to use can be obtained from local technicians of the Soil Conservation Service. Additional information and assistance can be obtained from the county agent and the Nebraska Game, Forestation and Parks Commission, Bureau of Sports Fisheries and Wildlife.

TABLE 3.—*Potential of soil associations for producing habitats for the more important species of wildlife*

Soil association	Wildlife	Potential for producing, for species of wildlife named—		
		Woody cover	Herbaceous cover	Food
Holdrege-Keith.	Pheasant	Good	Very good.	Good.
	Cottontail	Fair	Good	Fair.
	Deer	Good	Very good.	Good.
Hord, terrace-McCook-Bridgeport.	Pheasant	Good	Good	Very good.
	Quail	Good	Good	Very good.
	Cottontail	Good	Good	Good.
	Squirrel	Good	----------	Good.
	Deer	Fair	Good	Very good.
Sandy alluvial land-Las-Glenberg.[1]	Pheasant	Fair	Fair	Fair.
	Quail	Very good.	Good	Fair.
	Cottontail	Very good.	Good	Very good.
	Squirrel	Good	----------	Fair.
	Deer	Very good.	Good	Good.
	Furbearers	Fair	Fair	Fair.
	Waterfowl	----------	----------	
	Fish	----------	----------	
Colby.	Pheasant	Good	Very good.	Good.
	Cottontail	Fair	Good	Fair.
	Deer	Good	Very good.	Good.

[1] The potential for producing aquatic environment is good for furbearers and fish and fair for waterfowl.

Engineering Properties of the Soils[5]

Some properties of soils are of special interest to engineers because they affect construction and maintenance of highways, roads, airports, pipelines, foundations of buildings, and facilities for storing water, controlling erosion, irrigating and draining soils, disposing of sewage, and conserving soil and water. Some of these properties important to the engineer are texture, permeability, shear strength, plasticity, moisture-density relationships, compressibility, workability, and water-holding capacity. Information on topography and depth to water table, to bedrock, or to sand and gravel are also important.

Information in this report can be used to—

1. Make soil and land use studies that will aid in selecting and developing sites for industrial, business, residential and recreational use.
2. Make preliminary estimates of the engineering properties of soils for use in the planning and designing of structures and planning of measures for the conservation of soil and water.
3. Make preliminary evaluations of soil and ground conditions that will help in selecting locations for highways and airports and in planning detailed investigations at the selected locations.
4. Estimate drainage areas and runoff characteristics for use in the designing of culverts and bridges.
5. Classify soils along a proposed highway route for use in making preliminary estimates of the required thickness for flexible pavement.
6. Estimate the need for clay to stabilize the surfacing on roads that are not paved.
7. Locate deposits of sand, gravel, rock, mineral filler, and soil binder for use in constructing sub-base courses, base courses, and surface courses for flexible pavements for highways and structures.
8. Make preliminary evaluations of terrain, such as topography, surface drainage, subsurface drainage, depth to water table, and other features that need to be considered in designing highway embankments, subgrades, and pavements.
9. Correlate performance of engineering measures and structures with soil mapping units, and thus develop information that will be useful in designing and maintaining these measures and structures.
10. Determine the suitability of soils for the cross-country movement of vehicles and construction equipment.
11. Supplement the information obtained from other published maps, reports, and aerial photographs to make maps and reports that can be readily used by engineers.
12. Develop other preliminary estimates for construction purposes, pertinent to the particular area.

Used with the soil map to identify the soils, the engineering interpretations in this section can be useful for many purposes. It should be emphasized that the interpretations may not eliminate the need for sampling and testing at the site of specific engineering works involving heavy loads and where the excavations are deeper than the depths

[5] By H. GLEN BUCHTA, area engineer, and NORMAN W. HUBER, soil scientist, assisted by LEE E. SMEDLEY, assistant State conservation engineer, all of Soil Conservation Service, and by WILLIAM J. RAMSEY, field geologist, Division of Materials and Tests, Nebraska Department of Roads. The work by the Department of Roads was provided under a cooperative agreement with the U.S. Department of Commerce, Bureau of Public Roads.

of layers here reported. Nevertheless, even in such situations, the soil map is useful for planning more detailed field investigations and for suggesting the kinds of problems that may be expected.

Some of the terms used by the soil scientist may be unfamiliar to the engineer, and some words, for example, soil, clay, silt, sand, and aggregate, have special meaning in soil science. Most of these terms, as well as other special terms used in the soil survey report, are defined in the Glossary.

Engineering classification systems

Two systems of classifying soils are in general use among engineers, and both are used in this report. It is assumed that any person using this report is familiar with these systems or has available reference material on these two classification systems.

Most highway engineers classify soil materials in accordance with the system approved by the American Association of State Highway Officials (AASHO) (*1*). In this system soil materials are classified in seven principal groups. The groups range from A–1, consisting of gravelly soils of high bearing capacity, to A–7, which is made up of clay soils having low strength when wet. Within each group, the relative engineering value of the material is indicated by a group index number. The group index for the soil groups A–1, A–2, and A–3 is 0, except that the poorest soils in group A–2 have a group index of 4. The poorest soils in group A–4 have a group index of 8; those in group A–5 have a group index of 12; in group A–6, 16; and in A–7, 20. In table 4 the group index number is shown in parentheses after the soil group symbol.

Some engineers prefer to use the Unified soil classification system (*8*). This system is based on identifying the soils according to their texture and plasticity, and the soils are grouped according to their performance as engineering construction materials. The soil materials are classified as coarse grained, eight classes; fine grained, six classes; and highly organic material. These classes, designated by pairs of letters, range from GW to Pt. Class GW consists of well-graded gravel or of mixtures of gravel and sand that contain little or no fines. Class Pt consists of peat and other highly organic soils. Dual classification symbols are provided for soils that have characteristics of two classes.

The Unified system provides for both a simple field method and a laboratory method for determining the grain size and plastic properties of the soils. Both methods are based on gradation and plasticity and vary only in degree of accuracy. The laboratory method uses mechanical analyses, liquid limit data, and plasticity indexes for exact classification. A plasticity chart on which the liquid limit and the plasticity index may be plotted is used for a more accurate classification of the fine-grained soils. Classification of the tested soils according to the Unified system is given in the last column of table 4.

Engineering test data

To be able to make the best use of the soil map and the soil survey reports, the engineer should know the physical properties of the soil materials and the condition of the soil in place. After testing soil materials and observing the behavior of soil in engineering structures and foundations, the engineer can develop designs that are best suited to the soils on the map.

In table 4 are given the engineering test data for samples of several different soils. The samples were taken from representative sites by the soil scientist while mapping. The testing, by the Division of Materials and Tests, Nebraska Department of Roads, was done according to standard procedures of the American Association of State Highway Officials. Each soil was sampled by natural horizons. The Soil Conservation Service designates horizons as A, B, and C. Further explanation of horizon designations generally used by soil scientists is given in the Glossary of this report.

The soils listed in table 4 were sampled at only one location and show the engineering characteristics of the soil at that specific location. In evaluating the data, it must be recognized that these soils vary according to their location, and that the test data may not show the maximum range in characteristics of the materials that may occur.

Table 4 gives moisture-density relationships (compaction data) for the soils tested. If a soil material is compacted at successively higher moisture content, assuming that the compactive effort remains constant, the dry density of the compacted material increases until the optimum moisture content is reached. After that the dry density decreases with an increase in moisture. The highest dry density obtained in the compaction test is called the maximum dry density. Moisture-density data are important in earthwork, because the soil is generally most stable if it is compacted to about the maximum dry density when it is at approximately the optimum moisture content.

The classifications in the last two columns of table 4 are based on data obtained by mechanical analyses and by tests to determine liquid limits and plastic limits. The mechanical analyses were made by the combined sieve and hydrometer methods.

Tests for liquid limit and plastic limit measure the effect of water on the consistence of the soil material. As the moisture content of a clayey soil increases from a very dry state, the material changes from a semisolid to a plastic state. If more water is added, the material changes from a plastic to a liquid state. The *plastic limit* is the moisture content expressed as a percentage of the oven-dry weight of the soil, at which the material passes from a semisolid to a plastic state. The *liquid limit* is the moisture content at which the material passes from a plastic to a liquid state. The *plasticity index* is the numerical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which a soil material is in a plastic condition. Some silty and sandy soils are nonplastic; that is, they will not become plastic at any moisture content.

Additional detailed information on the soils of Red Willow County is shown under the sections "Descriptions of the Soils" and "Formation, Classification, and Morphology of Soils."

Engineering descriptions of soils

Table 5 gives a brief description of the soils in the county and estimates of their physical properties. The test data in table 4, information from the rest of the soil survey, and facts known about the different soils in the county were used as a basis for preparing the data in this table. The AASHO and Unified classifications were also made by using this information.

TABLE 4.—*Engi*

[Tests performed by Nebraska Department of Roads in cooperation with U.S. Department of Commerce in

Soil name and location	Parent material	Nebraska report No. (S-62)	Depth	Horizon	Moisture-density[1]	
					Maximum dry density	Optimum moisture
			Inches		*Lb. per cu. ft.*	*Percent*
Bridgeport silt loam:						
0.1 mile E. and 0.125 mile S. of NW. corner of sec. 36, T. 4 N., R. 26 W.	Colluvium.	5223	0–15	A	101	20
		5224	20–48+	C	102	20
0.2 mile S. and 150 feet W. of NE. corner of sec. 19, T. 3 N., R. 30 W.	Colluvium.	5228	0–12	Ap and AC	104	18
		5229	12–36+	C	111	15
Colby silt loam:						
0.2 mile E. and 250 feet S. of NW. corner of sec. 10, T. 3 N., R. 30 W.	Peorian loess.	5239	0–6	A1	100	19
		5240	10–48+	C	106	18
Glenberg fine sandy loam:						
0.25 mile N. and 0.25 mile E. of SW. corner of sec. 10, T. 3 N., R. 27 W.	Alluvium.	6171	0–6	Ap	117	10
		6172	6–18	AC	116	12
		6173	18–36+	C	116	11
Holdrege silt loam:						
0.2 mile W. and 100 feet N. of SE. corner of sec. 23, T. 4 N., R. 26 W.	Peorian loess.	5236	0–7	Ap	106	17
		5237	11–20	B2	100	20
		5238	23–60+	C	104	19
Hord silt loam:						
0.4 mile E. and 0.25 mile S. of NW. corner of sec. 1, T. 3 N., R. 27 W.	Loess and alluvium.	5220	0–15	A	105	18
		5221	15–27	B2	105	18
		5222	39–60+	C	107	18
Hord silt loam, terrace:						
0.45 mile N. and 0.45 mile E. of SW. corner of sec. 6, T. 2 N., R. 29 W.	Alluvium and loess.	5233	0–11	Ap	102	18
		5234	15–26	B2	103	19
		5235	26–48+	BC	103	20
Keith silt loam:						
0.3 mile S. and 100 feet E. of NW. corner of sec. 32, T. 4 N., R. 30 W.	Peorian loess.	5225	0–11	A	105	18
		5226	18–25	B2	103	18
		5227	25–48+	C	104	19
McCook loam, overflow:						
0.4 mile S. and 300 feet W. of NE. corner of sec. 28, T. 1 N., R. 28 W.	Alluvium.	5230	0–8	Alp	108	16
		5231	12–23	C	105	17
		5232	26–48	Cb	110	16
Ulysses silt loam:						
0.2 mile N. and 0.25 mile E. of SW. corner of sec. 32, T. 4 N., R. 26 W.	Peorian loess.	6168	0–7	A1	105	18
		6169	7–16	B2	103	19
		6170	19–48+	C	102	20
0.2 mile S. and 300 feet E. of NW. corner of sec. 16, T. 3 N., R. 30 W.	Peorian loess.	5241	0–7	A1	102	18
		5242	7–13	B2	105	18
		5243	17–48+	C	108	18

[1] Based on AASHO Designation: T 99–57, Method A (*1*).

[2] Mechanical analyses according to the AASHO Designation: T 88–57 (*1*). Results by this procedure frequently may differ somewhat from results that would have been obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO procedure the fine material is analyzed by the hydrometer method and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analyses used in this table are not suitable for use in naming textural classes for soils.

neering test data

accordance with standard procedures of the American Association of State Highway Officials (AASHO) (*1*)]

Mechanical analysis [2]								Liquid limit	Plasticity index	Classification	
Percentage passing sieve—				Percentage smaller than—							
No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.02 mm.	0.005 mm.	0.002 mm.			AASHO [3]	Unified [4]
--------	--------	100	96	82	42	22	16	36	11	A-6(8)	ML-CL.
--------	--------	100	96	86	48	29	21	40	18	A-6(11)	CL.
--------	--------	100	96	80	36	18	13	35	11	A-6(8)	ML-CL.
--------	--------	100	84	56	25	14	11	27	6	A-4(8)	ML-CL.
--------	--------	100	92	79	31	17	12	33	9	A-4(8)	ML-CL.
--------	--------	100	98	84	30	12	8	29	6	A-4(8)	ML-CL.
100	99	89	37	20	9	4	3	(5)	(5)	A-4(0)	SM.
--------	100	93	47	30	13	6	4	(5)	(5)	A-4(2)	SM.
100	97	89	37	18	7	3	3	(5)	(5)	A-4(0)	SM.
--------	--------	100	97	84	40	22	18	29	6	A-4(8)	ML-CL.
--------	--------	100	97	84	46	30	26	41	20	A-7-6(12)	CL.
--------	--------	100	97	82	39	20	13	32	10	A-4(8)	ML-CL.
--------	--------	100	97	86	34	17	12	31	8	A-4(8)	ML-CL.
--------	--------	100	96	80	32	15	10	33	10	A-4(8)	ML-CL.
--------	--------	100	96	84	30	16	12	32	10	A-4(8)	ML-CL.
--------	--------	100	97	80	34	18	14	35	10	A-4(8)	ML-CL.
--------	--------	100	98	84	40	23	18	34	12	A-6(9)	ML-CL.
--------	--------	100	98	84	40	26	21	37	15	A-6(10)	CL.
--------	--------	100	93	80	33	18	12	30	7	A-4(8)	ML-CL.
--------	--------	100	94	78	40	27	24	39	18	A-6(11)	CL.
--------	--------	100	96	80	40	22	16	33	10	A-4(8)	ML-CL.
--------	--------	100	87	70	22	10	7	27	5	A-4(8)	ML-CL.
--------	--------	100	93	75	23	10	8	28	4	A-4(8)	ML-CL.
--------	--------	100	86	70	22	10	8	25	3	A-4(8)	ML.
--------	--------	100	97	79	35	21	17	32	9	A-4(8)	ML-CL.
--------	--------	100	97	82	40	26	22	36	14	A-6(10)	CL.
--------	--------	100	98	87	47	28	21	36	14	A-6(10)	CL.
--------	--------	100	95	79	32	17	12	32	7	A-4(8)	ML-CL.
--------	--------	100	95	79	35	22	18	36	13	A-6(9)	ML-CL.
--------	--------	100	94	76	33	20	15	31	9	A-4(8)	ML-CL.

[3] Based on AASHO Designation: M 145-49 (*1*).

[4] Based on Unified Soil Classification System (*8*). SCS and BPR have agreed to consider that all soils having plasticity indexes within two points from A-line are to be given a borderline classification. An example of a borderline classification obtained by this use is ML-CL.

[5] Nonplastic.

TABLE 5.—*Brief descriptions of soils of Red Willow*

Map symbol	Soil name	Description of soil and site: Position	Underlying material [1]	Runoff	Depth to water table	Depth to bedrock or sand and gravel
					Feet	*Feet*
Bb	Bankard fine sand.	Bottom lands	Stratified sand and gravel.	Very slow	6–10	3–5
Bc	Bankard loamy fine sand.	Bottom lands	Stratified sand and gravel.	Very slow	6–10	3–5
Bn	Barney silty clay loam.	Bottom lands	Stratified sand and gravel.	Slow	1–3	1–3
Bf BfA 2Bk	Bayard fine sandy loam, 0 to 1 percent slopes.[2] Bayard fine sandy loam, 1 to 3 percent slopes. Bayard loam, slightly wet.	Terraces and foot slopes.	Statified silt and sand.	Slow	([3])	([4])
Br BrA BrB	Bridgeport silt loam, 0 to 1 percent slopes. Bridgeport silt loam, 1 to 3 percent slopes.[2] Bridgeport silt loam, 3 to 6 percent slopes.	Foot slopes	Silt	Slow to medium.	([3])	([4])
Sy	Broken alluvial land.	Bottom lands	Stratified silt and sand.	Slow	([3])	([4])
CbCW CbDW	Colby silt loam, 3 to 9 percent slopes.[2] Colby silt loam, 9 to 30 percent slopes.	Uplands	Silt (Peorian loess)	Medium to very rapid.	([3])	([4])
Gd 2Gd	Glenberg fine sandy loam.[2] Glenberg fine sandy loam, slightly wet.	Bottom lands	Stratified silt and sand.	Slow	3–10	7–12
GK	Glenberg loam.	Bottom lands	Stratified silt and sand.	Slow	3–10	7–12
Hf	Haverson fine sandy loam.	Bottom lands	Stratified silt and sand.	Slow	6–10	7–12
HK HKA HKA2 HKB HKB2	Holdrege and Keith silt loams, 0 to 1 percent slopes.[2] [6] Holdrege and Keith silt loams, 1 to 3 percent slopes. Holdrege and Keith silt loams, 1 to 3 percent slopes, eroded. Holdrege and Keith silt loams, 3 to 6 percent slopes. Holdrege and Keith silt loams, 3 to 6 percent slopes, eroded.	Uplands	Silt (Peorian loess)	Slow to medium.	([3])	([4])
Hd 2Hd 2HdA	Hord silt loam, 0 to 1 percent slopes. Hord silt loam, terrace, 0 to 1 percent slopes.[2] Hord silt loam, terrace, 1 to 3 percent slopes.	Uplands	Stratified silt	Slow to medium.	20–30	([4])
HSs	Hord-slickspot complex.[5]	Terraces	Stratified silt and sand.	Slow	([3])	([4])
Lt 2Lt 2Lz	Las loam. Las loam, saline-alkali. Las sand, overwash.	Bottom lands	Stratified silt and sand.	Slow	3–6	7–12

See footnotes at end of table.

County, Nebr., and their estimated physical properties

Depth from surface	Classification			Percentage passing sieve—			Perme-ability	Avail-able water capacity	Shrink-swell potential
	USDA texture	Unified	AASHO	No. 4	No. 10	No. 200			
Inches							*Inches per hour*	*Inches per inch of soil*	
0–13	Fine sand	SP-SM or SM	A–3 or A–2		100	10–20	5. 0–10. 0	0. 07	Low.
13–40	Fine sand	SP-SM	A–3 or A–2		100	5–15	5. 0–10. 0	. 06–. 08	Low to none.
40–60	Sand and gravel	SP-SM or SM	A–3 or A–2	100	75–95	10–25	10+	. 05–. 06	None.
0–14	Loamy fine sand	SM	A–2		100	15–25	5. 0–10. 0	. 10	Low.
14–28	Fine sand	SP-SM	A–3 or A–2		100	6–12	5. 0–10. 0	. 06–. 08	Low to none.
28–60	Sand and gravel	SP-SM or SM	A–3 or A–2	100	75–95	10–25	10+	. 05–. 06	None.
0–6	Silty clay loam	CL	A–7		100	90–100	. 20–0. 80	. 17	Moderate.
6–12	Fine sand	SP-SM or SM	A–3 or A–2		100	5–15	5. 0–10. 0	. 06–. 08	Low to none.
12–60	Sand and gravel	SP or SP-SM	A–3	90–100	75–85	0–10	10+	. 04–. 06	None.
0–16	Fine sandy loam	SM	A–2 or A–4	100	95–100	35–49	2. 5–5. 0	. 15	None to low.
16–28	Loamy fine sand	SM	A–2		100	25–35	5. 0–10. 0	. 10	None to low.
28–48	Fine sandy loam	SM	A–2 or A–4	100	95–100	35–49	2. 5–5. 0	. 15	None to low.
0–12	Silt loam	ML or CL	A–4 or A–6		100	90–100	0. 8–2. 5	. 16	Low to moderate.
12–36	Silt loam	ML	A–4		100	80–95	0. 8–2. 5	. 16	Low.
36–60	Silt loam	ML	A–4		100	80–95	0. 8–2. 5	. 16	Low.
--------	--------	--------	--------	--------	--------	--------	--------	--------	
0–48	Silt loam	ML or CL	A–4 or A–6		100	90–100	0. 8–2. 5	. 16	Low to moderate.
0–6	Fine sandy loam	SM	A–2 or A–4	100	95–100	30–40	2. 5–5. 0	. 15	None.
6–18	Fine sandy loam	SM	A–4		100	40–49	2. 5–5. 0	. 15	None.
18–48	Fine sandy loam	SM	A–2 or A–4	100	95–100	30–40	2. 5–5. 0	. 15	None.
0–10	Loam	ML	A–4	100	85–95	55–60	0. 80–2. 5	. 16	None to low.
10–48	Fine sandy loam	SM	A–2 or A–4	100	95–100	35–45	2. 5–5. 0	. 15	None.
0–16	Fine sandy loam	SM	A–2 or A–4	100	95–100	35–40	2. 5–5. 0	. 15	None.
16–32	Silt loam	ML	A–4		100	90–100	0. 8–2. 5	. 16	Low.
32–52	Fine sandy loam	SM	A–2 or A–4	100	95–100	30–40	2. 5–5. 0	. 15	None.
0–12	Silt loam	ML or CL	A–4 or A–6		100	90–100	0. 8–2. 5	. 16	Low.
12–23	Silt loam	CL	A–6 or A–7		100	90–100	0. 8–2. 5	. 16	Moderate.
23–48	Silt loam	ML or CL	A–4 or A–6		100	90–100	0. 8–2. 5	. 16	Low to moderate.
0–15	Silt loam	ML or CL	A–4		100	90–100	0. 8–2. 5	. 16	Low.
15–27	Silt loam	ML or CL	A–4		100	90–100	0. 8–2. 5	. 16	Low.
39–60+	Silt loam	ML or CL	A–4		100	90–100	0. 8–2. 5	. 16	Low.
0–18	Silt loam	ML or CL	A–4 or A–6		100	90–100	0. 80–2. 50	. 16	Moderate.
18–30	Silty clay loam	CL	A–7 or A–6		100	95–100	0. 20–0. 80	. 17	Moderate to high.
30–42	Fine sandy loam	SM	A–4	100	95–100	35–50	2. 5–5. 0	. 15	None to low.
42–60	Fine sand	SP–SM or SM	A–3 or A–2	100	95–100	5–15	5. 0–10. 0	06–. 08	None.
0–11	Loam	ML	A–4	100	80–95	55–60	0. 8–2. 5	·16	Low.
11–25	Silt loam	ML or CL	A–4 or A–6		100	90–100	0. 8–2. 5	. 16	Low to moderate.
25–36	Fine sandy loam	SM	A–2 or A–4	100	95–100	35–49	2. 5–5. 0	. 15	None to low.

TABLE 5.—*Brief descriptions of soils of Red Willow County,*

Map symbol	Soil name	Description of soil and site				
		Position	Underlying material [1]	Runoff	Depth to water table	Depth to bedrock or sand and gravel
					Feet	*Feet*
MH 2Mg	McCook and Haverson loams.[6] McCook loam, overflow.	Bottom lands	Stratified silt and sand.	Slow	6–10	7–12
BCa	Rough broken land, caliche.	Uplands	Limy sandstone	Very rapid	(3)	0–2
BL	Rough broken land, loess.	Uplands	Silt (Peorian loess)	Rapid to very rapid.	(3)	(4)
Sx	Sandy alluvial land.	Bottom lands	Stratified sand and gravel.	Very slow	3–6	7–12
UsB2 UsC UsC2	Ulysses silt loam, 3 to 6 percent slopes, eroded.[2] Ulysses silt loam, 6 to 9 percent slopes. Ulysses silt loam, 6 to 9 percent slopes, eroded.	Uplands	Silt (Peorian loess)	Medium to rapid.	(3)	(4)

[1] Materials are below the soil profile, generally at a depth of 4 to 10 feet.
[2] Classification and properties are those given for this soil; soils in the particular series are nearly uniform in given properties, except in runoff and slopes, degree of erosion, or alkalinity in small areas, as shown by soil name. The range given for runoff covers all the phases of slope and erosion listed.
[3] The water table is at a depth too great to be significant.

Runoff rates given in table 5 vary because of differences in relief and in soil characteristics. If the surface layer is medium textured or moderately coarse textured, the soils generally have slow or medium runoff and infiltration of water is moderate or moderately rapid. In general, runoff is slow on all nearly level or very gently sloping soils, as well as on soils that have a coarse-textured surface layer, but it is rapid or very rapid on the more steeply sloping soils.

The estimated range in the percentage of material passing sieves numbers 4, 10, and 200, as shown in table 5, reflects a normal range in the grain size for a given soil. The texture (grain size) of any soil varies considerably, especially that of materials formed in alluvium. It should not, therefore, be assumed that all samples of a soil fall within the range shown in table 5, nor that the engineering classification is always the same as shown.

Permeability refers to the rate at which water moves through soil material in its undisturbed state. The rate depends largely on texture and structure of the soil. The permeability ratings used in this report and their equivalents in words are as follows:

Inches per hour	*Rating*
0.05 to 0.2	Slow.
0.2 to 0.8	Moderately slow.
0.8 to 2.5	Moderate.
2.5 to 5.0	Moderately rapid.
5.0 to 10.0	Rapid.
More than 10.0	Very rapid.

Available water capacity, measured in inches of water per inch of soil, is the water available for plant use. It is the water held in a soil between field capacity and permanent wilting point.

Shrink-swell potential is the change in volume to be expected with a change in moisture content. In general, it is related to soil texture. In table 5 the shrink-swell potential of plastic silts and clays is rated as *moderate* to *high*, and that of nonplastic soils with no potential change in volume is rated as *none*. Soils that are intermediate in content of silt and clay and have a low or moderate plasticity index are rated as *low* or *moderate*. Some soils were given low or moderate ratings on the basis of comparisons with others of known mechanical analysis or plasticity rating. The only soil material that has moderate to high shrink-swell potential in this county is in one horizon of small areas of slickspots.

The reaction of individual soils in the county is not given in table 5. Reaction of a soil is generally expressed in pH values. For the soils of this county, the reaction generally ranges from pH 7.0 to 8.0 in the surface layer and from pH 7.5 to 8.5 in the lower horizons. Generally the soils are only slightly saline and contain 0.20 percent or less of soluble salts. Las loam, saline-alkali, is on the bottom lands, and Hord-slickspot complex is on terraces which contain variable amounts of excess sodium, or soluble salts, or both. Reaction in these soils ranges from pH 8.8 to 9.5.

Dispersion is generally not a problem in this county, though the rate of dispersion is high in Las loam, saline-alkali, and in areas of slickspots. Areas of these soils are small.

Nebr., and their estimated physical properties—Continued

Depth from surface	Classification			Percentage passing sieve—			Perme-ability	Avail-able water capacity	Shrink-swell potential
	USDA texture	Unified	AASHO	No. 4	No. 10	No. 200			
							Inches per hour	*Inches per inch of soil*	
0–16	Loam	ML	A–4	100	85–95	51–60	0. 8–2. 5	. 16	None to low.
16–43	Loam	ML or CL	A–4		100	90–100	0. 8–2. 5	. 16	Moderate.
43–60	Very fine sandy loam.	SM	A–4	100	95–100	36–45	2. 5–5. 0	. 15	None.
0–60	Silt loam	ML or CL	A–4		100	90–100	0. 8–2. 5	. 16	Low to moderate.
0–8	Fine sand	SP–SM or SM	A–3 or A–2	100	95–100	5–15	5. 0–10. 0	. 07	None.
8–60	Sand and gravel	SP	A–3		100	0–5	10+	. 05–. 06	None.
0–6	Silt loam	ML or CL	A–4		100	90–100	0. 8–2. 5	. 16	Low.
6–14	Silt loam	ML or CL	A–4 to A–7		100	90–100	0. 8–2. 5	. 16	Moderate.
14–48	Silt loam	ML or CL	A–4 or A–6		100	90–100	0. 8–2. 5	. 16	Low.

[4] Bedrock or sand and gravel are below the depth that is normally sampled.
[5] Data are given for the slickspot soils. See Hord silt loam for data on Hord soils.
[6] Both soils in this undifferentiated unit are similar in description, classification, and properties, and estimates were made on this basis.

Engineering interpretations of soils

Table 6 shows the suitability of the soils as sources of material for topsoil, sand, and road fill and their suitability as a road subgrade. This table also lists soil features that affect the use of soils for highways and conservation engineering practices.

The ratings given the soils for suitability of soil material for topsoil, sand, and for sand and gravel apply only in Red Willow County. Some of the soils are rated *poor* or *fair* as a source of topsoil because they are eroded or are low in natural fertility or content of organic matter. Soils that are rated *fair* or *good* as a possible source of sand or of sand and gravel may still require extensive exploring to find material that will meet gradation requirements.

Suitability of the soils as material for road subgrade is shown for bituminous or concrete pavement and for gravel roads. The ratings given in the column headed *Paved* refer to the subgrade underlying the roadbed for bituminous and concrete pavement. Because properly confined sand is the best subgrade for roads having bituminous and concrete pavement, the soil is rated *good* for the subgrade if the AASHO classification is A–1 or A–3. If the AASHO classification is A–2, the soil is rated *good* to *fair*. The rating is *fair* to *poor* for material classified as A–4, and *poor* for that classified as A–6 or A–7.

The ratings given in the column headed *Gravel* refer to the part of the subgrade that receives gravel surfacing. Since sand is noncohesive, it does not provide a stable surface. All soils classified A–1 or A–3 and those classified A–2 that do not have adequate plasticity are rated *poor*. Soils classified A–4 and A–2 that have adequate plasticity are rated *good* to *fair*. Silts or clays classified A–6 or A–7 are usually acceptable for use in the part of the upper subgrade that receives gravel surfacing and are rated *good*.

Ratings for the soils in the column headed *Road fill* were based on about the same criteria as ratings of soils for subgrade under bituminous or concrete pavement. A range in ratings in all three columns (Paved, Gravel, Road fill) indicates variations in the soil profile.

The suitability of the soils for winter grading is not given in table 6. Whether or not a soil can be graded in winter depends on the moisture content and temperature of a soil, both of which are likely to vary from year to year. Most soils in the county have a relatively high content of silt and therefore few of the soils that receive rain in fall are suited to winter grading. Soils on the bottom lands that have a high water table or are subject to infrequent floods are also not suited to winter grading.

In general, the soil features listed in table 6 as affecting engineering practices were rated according to the extent or the problems affecting the construction and maintenance of highways and of agricultural structures and practices. The soil features shown for a given soil were based on the profile of that soil described in table 5. Ratings of the soil for use in some structures change according to variations in the profile.

Frost action is a common but not a major engineering problem in the county. The ratings for susceptibility to frost action in the column headed *Highway location* were made on the basis of the texture of the surface soil and the subsoil. Clays and silts are susceptible to frost action if the underlying soil layers are pervious enough for water to rise and form ice lenses.

TABLE 6.—*Engineering interpretations*

Soil series and map symbols	Suitability: As source of— Topsoil	Suitability: As source of— Sand	Suitability: As source of— Sand and gravel	Suitability: Of soil material for— Road subgrade: Paved	Suitability: Of soil material for— Road subgrade: Gravel	Suitability: Of soil material for— Road fill	Soil features affecting— Highway location	Soil features affecting— Foundations
Bankard (Bb, Bc)	Poor	Good below a depth of 3 feet.	Poor	Good	Poor	Good	Low susceptibility to frost action.	Good to fair bearing capacity; slight piping hazard in places.
Barney (Bn)	Poor	Poor	Fair to good below a depth of 2 feet.	Good	Poor	Good	Underlying material has low susceptibility to frost action; may require 7 feet of fill if water table is high; remove surface soil.	Good bearing strength but has high water table.
Bayard (Bf, BfA, 2Bk)	Fair	(2)	(2)	Fair to poor.	Good to fair.	Fair	Moderate susceptibility to frost action; embankment and back slopes highly erodible.	Good to poor bearing capacity, depending on density; moderate to high piping hazard.
Bridgeport (Br, BrA, BrB).	Good to fair.	(2)	(2)	Fair to poor.	Good to fair.	Fair	High to very high susceptibility to frost action; slopes erodible.	Fair to poor bearing capacity; moderate piping hazard.
Broken alluvial land (Sy).[3]								
Colby (CbCW, CbDW)	Fair	(2)	(2)	Fair to poor.	Good to fair.	Fair	High to very high susceptibility to frost action; slopes erodible in places.	Fair to poor bearing capacity; high to moderate piping hazard.
Glenberg (Gd, 2Gd, GK)	Good	Good; fine- to medium-textured sand below a depth of 3 feet in imperfectly drained phase.	(2)	Fair to poor.	Fair	Fair	Moderate to high susceptibility to frost action; embankment and back slopes highly erodible; may require minimum fill if water table is high.	Good to poor bearing capacity depending on density; subject to piping in places.
Haverson (Hf)	Good	(2)	(2)	Fair to poor.	Good to fair.	Fair	High to very high susceptibility to frost action; subject to flooding in places.	Fair to poor bearing capacity; moderate to high piping hazard.

See footnotes at end of table.

of soils of Red Willow County, Nebr.

Soil features affecting—Continued						Limitations for—	
Dikes and levees	Low dams: Reservoir	Low dams: Embankment	Agricultural drainage	Irrigation	Terraces and diversions	Septic tanks and filter beds	Sewage lagoons
Subject to piping in places.	On flood plains; generally not used for reservoirs.	(1)	(1)	Very low to low water-holding capacity; rapid intake rate; adequate drainage is needed; low in fertility.	(1)	Slight	Severe; high permeability.
(1)	On flood plains; generally not used for reservoirs.	(1)	Surface drainage moderately slow; internal drainage above subsoil poor; subject to flooding; high water table.	Low water-holding capacity; slow intake rate.	(1)	Severe; high water table; poorly drained.	Severe; high permeability.
Piping a problem in places; slopes highly erodible.	Moderate to high seepage.	Fair stability; subject to piping; may need toe drains; slopes require protection.	(1)	Moderate water-holding capacity.	Highly erodible; maintenance may be costly.	Slight	Severe; high permeability; subject to severe piping.
Moderate piping hazard; slopes require protection in places.	Seepage generally not a problem.	Fair to poor stability; close control required; may need toe drains.	(1)	Moderate water-holding capacity.	Highly erodible.	Slight	Moderate to severe; moderate permeabilty.
Moderately erodible.	Moderate to high seepage.	Fair to poor stability if control is close; toe drains may be needed.	(1)	Moderate water-holding capacity; steep slopes erodible.	Moderately erodible.	Moderate to severe on steeper slopes.	Moderate to severe on steeper slopes.
Piping a problem in places; slopes erodible.	Moderate to high seepage varying with amount of fines.	Fair to poor stability; some areas have high water table; slopes require protection.	(1)	Moderate to low water-holding capacity; adequate drainage needed.	(1)	Moderate to severe if water table is high.	Severe; rapid permeability; subject to piping.
Severe piping hazard; slopes highly erodible.	Seepage generally not a problem.	Fair to poor stability; subject to piping; may need toe drains; slopes erodible.	(1)	Moderate water-holding capacity; subject to flooding in places.	(1)	Moderate to severe; subject to flooding in places.	Moderate to severe; moderate permeabilty.

TABLE 6.—*Engineering interpretations*

Soil series and map symbols	Suitability						Soil features affecting—	
	As source of—			Of soil material for—			Highway location	Foundations
	Topsoil	Sand	Sand and gravel	Road subgrade: Paved	Road subgrade: Gravel	Road fill		
Holdrege and Keith (HK, HKA, HKA2, HKB, HKB2).	Good	(2)	(2)	Fair to poor.	Good	Fair	High susceptibility to frost action; slopes erodible in places.	Good to fair bearing capacity; moderate piping hazard.
Hord (Hd, 2Hd, 2HdA)	Good	(2)	(2)	Fair to poor.	Good	Fair	High susceptibility to frost action; slopes erodible in places.	Fair to good bearing capacity; moderate piping hazard.
Hord-slickspot (HSs) [4]								
Las (Lt, 2Lt, 2Lz)	Fair	Fair to good below depth of 3 feet.	(2)	Good to poor.	Good to poor.	Good to fair.	Low to high susceptibility to frost action; may require minimum fill; slopes erodible in places.	Good to poor bearing capacity; subject to piping if sand is silty.
McCook (MH, 2Mg) [5]	Good	(2)	(2)	Fair to poor.	Good to fair.	Fair	High susceptibility to frost action; subject to flooding in places.	Fair to poor bearing capacity; moderate to high piping hazard.
Rough broken land, caliche (BCa).[3]								
Rough broken land, loess (BL).	Poor	(2)	(2)	Fair to poor.	Good	Fair	High susceptibility to frost action; slopes highly erodible.	Good to poor bearing capacity; subject to piping in places.
Sandy alluvial land (Sx)	Poor	Good; medium- and fine-textured sand below a depth of 1 foot.	(2)	Good	Poor	Good	Water table is near the surface in places; may require 4 feet of fill; slopes erodible in places.	Fair to poor bearing capacity; piping hazard if sand is silty.
Ulysses (UsB2, UsC, UsC2).	Fair	(2)	(2)	Fair to poor.	Good	Fair	High susceptibility to frost action; slopes erodible in places.	Good to poor bearing capacity; silt causes a piping hazard.

[1] Generally not needed, because of position, topography or slope.
[2] Sand or sand and gravel generally not available.

of soils of Red Willow County, Nebr.—Continued

Soil features affecting—Continued						Limitations for—	
Dikes and levees	Low dams		Agricultural drainage	Irrigation	Terraces and diversions	Septic tanks and filter beds	Sewage lagoons
	Reservoir	Embankment					
(1)	Seepage not a problem.	Fair stability; good to poor resistance to piping.	(1)	Moderate water-holding capacity.	Slightly erodible.	Slight	Moderate to severe; moderate permeability; on steeper slopes cost may be excessive.
Piping a problem in places; slopes moderately erodible.	Seepage not a problem.	Good to fair stability; good to poor resistance to piping.	(1)	Moderate water-holding capacity.	Slightly erodible.	Slight	Moderate to severe.
(1)	Unless sandy substratum is exposed, seepage generally is not a problem.	Good to poor stability; may need toe drains; close control may be required.	Seasonal high water table; fair internal drainage.	Moderate to low water-holding capacity; adequate drainage needed in places; areas may be best suited to crops that tolerate alkali.	(1)	Moderate to severe; high water table.	Severe; high permeability; subject to piping in places.
Severe piping hazard; highly erodible.	Seepage generally not a problem.	Fair to poor stability; subject to piping; may need toe drains; slopes erodible.	Subject to occasional flooding; fair to good internal drainage.	Moderate water-holding capacity; subject to flooding in places.	Moderately erodible.	Moderate to severe; subject to flooding in places.	Moderate to severe; moderate permeability.
------	------	------	------	------	------	------	
(1)	Low seepage and generally not a problem.	Good to poor stability; may need toe drains.	(1)	(1)	Not applicable.	Severe	Severe.
Subject to piping in places.	High seepage, especially if subsoil is exposed; slopes erodible.	Fair to poor stability; piping hazard severe in places.	Subject to occasional flooding; seasonal high water table; slow runoff.	(1)	Not applicable.	Moderate to severe; high water table; subject to flooding.	Moderate to severe; high permeability.
(1)	Low seepage and generally not a problem.	Fair stability; close control may be required.	(1)	Moderate water-holding capacity; steep slopes are erodible.	Moderately erodible.	Slight	Moderate to severe; moderate permeability; on steeper slopes cost may be high.

[3] Because of variable characteristics, classification or engineering interpretations cannot be made.
[4] See Hord soils for engineering interpretations. Areas in slickspots need local evaluation.
[5] Estimated interpretations are given for the McCook soils.

Ratings for susceptibility to frost action (heaving) are based on classification of the surface soil. Soils that are classified as ML, CL, or SM are rated *very high*, *high*, or *moderate*. Soils that are classified as CH are rated *high*, *moderate*, or *low*, and those classified as SP or SW are rated *low* or *none*.

For fine-grained soils that have a surface soil classified as ML, CL, or CH, the amount of clay material in the subsoil was considered in the rating. For example, if the surface soil is classified as ML and the subsoil is less than 40 percent clay (particles 0.005 millimeter in size), *very high*, the highest rating is used. Uniform fine sands that have a surface soil classified as SM but that contain a small amount of fines (less than 35 percent of particles 0.074 millimeter or less in size) are rated *low* to *none*.

In the column headed *Foundations* the bearing quality and piping hazard are rated for the part of the soil at a depth of more than 3 feet.

Soil features affecting construction and maintenance of low dikes and levees are shown in table 6, and the information given is for materials in only the upper 18 inches of the soil. If larger dikes or levees are to be constructed, a detailed investigation of each site is needed.

Water is lost through seepage in most reservoirs above small earth dams, because the dams are located on soils that have sandy or gravelly lower horizons, and sealing is needed for controlling losses.

Compacted embankments that are constructed of material other than sand or sand and gravel are generally impervious and have *good* to *poor* stability but toe drains may be needed. Workability of most soil materials is generally good.

The kind of agricultural drainage that can be effectively used is determined by relief, soil permeability, the height of the water table, and the availability of outlets. Some soils on bottom lands have imperfect drainage or poor drainage because of a seasonally high water table, slow permeability, or both. Several of the soils are subject to flooding. Others are nearly level and have slow runoff.

In the column headed *Irrigation*, features that affect the available water (water-holding capacity and water-intake rate) are given. Irrigation hazards that are caused by slope are not shown. The "Nebraska Irrigation Guide for Central and Eastern Nebraska," of the Soil Conservation Service, issued in September 1959, contains information on the suitability of various soils for irrigation and on the use of soil amendments. The ratings for water-holding capacity in table 5 are for the top 4 feet of soil. The terms used to indicate the amount of water held are as follows:

Water-holding capacity:	*Rating*
More than 8 inches	High.
5 to 8 inches	Moderate.
3 to 5 inches	Low.
Less than 3 inches	Very low.

The intake of water is shown in the column headed *Irrigation* only if the rate is *rapid* or *slow*. A *slow* intake rate is less than 1/2 inch per hour, and a *rapid* intake rate is 2 inches or more per hour. If the intake rate is not shown, it falls between the two extremes. The intake rate for all soils is based on border or sprinkler irrigation of areas that have a cover of plants.

Level terraces are generally used in this county to conserve soil and water. Diversions are sometimes used below pastured areas for protecting lower lying soils, many of which are very productive. The slopes of terraces are generally erodible, but in most places the cost of maintenance is not very high. In some areas that have steep, irregular, or hummocky slopes the use of terraces is limited.

The soils have not been rated in table 6 as to properties that affect suitability for waterways. Waterways are not commonly used in dryland areas, but they are used extensively for water disposal in irrigated areas that are contour bench leveled. Such areas have no special problems or hazards in regard to construction and maintenance of waterways.

The limitations of a soil for septic tanks and filter beds are also given in table 6. The most common method of sewage disposal for homes outside a city sewage disposal system is the use of a septic tank and filter bed. Sewage lagoons may be used for small towns and small housing developments. Such terms as *severe* or *moderate to severe* are used for soils having properties that generally limit the use of a specified type of sewage disposal in both types of drainage systems. Since percolation tests have not been run on these soils, part of the ratings were made only on the basis of permeability. Also, the measure of the ability of a soil to absorb sewage is here given over a short period and does not necessarily apply to a long period. Before installing a septic tank and filter bed, percolation tests need to be run on soils that have moderate or severe limitations. Furthermore, the proximity of the structures to wells and the potential danger of contamination need to be considered.

Properties of the soil such as high permeability, steepness of slopes, and piping and other construction problems on embankments were used in rating the suitability of the soils for sewage lagoons. Treatment of the soils with bentonite or one of the polyphosphates for reducing perviousness is needed in places.

Formation, Classification, and Morphology of Soils

This section contains a discussion of the factors of soil formation; a brief description of a system of classification of the soils; and a description of each soil series, including a typical profile of each.

In Red Willow County the climate and plant and animal life are uniform throughout the county. Local differences in soils are therefore mainly the result of differences in parent material, relief, and time.

Factors of Soil Formation

Soil is formed by weathering and other processes that act on materials deposited or accumulated by geologic agencies. The characteristics of the soil at any given point depend upon (1) the physical and mineralogical composition of the parent material, (2) the climate under which the soil material has accumulated and existed since accumulation, (3) the plant and animal life on and in the soil, (4) the relief, or lay of the land, and (5) the length of time the forces of soil development have acted on the soil material.

Climate and plant and animal life are active factors of soil formation. They act on the parent material accumulated through the weathering of rocks and slowly change

it into a natural body with genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material also affects the kind of profile that can be formed and in extreme cases determines it almost entirely. Finally, time is needed for the changing of the parent material into a soil profile. The amount of time may be much or little, but generally a long time is required for distinct horizons to develop.

The factors of soil genesis are so closely interrelated in their effects on the soil that few generalizations can be made about the effect of any one factor unless conditions are specified for the other four. Many of the processes of soil formation are unknown.

Parent material

The soils of Red Willow County have developed from three kinds of parent material. There are (1) windblown silt (Peorian loess); (2) colluvium; and (3) alluvium. The most extensive of these are the soils formed in windblown silt. All of the materials were deposited in late geologic time, during the Pleistocene epoch. There are also outcrops of rocks from the Ogallala formation.

Windblown silt.—Silt laid down by wind forms a mantle over all but the river channels (fig. 16) in the county. Some of the most fertile soils in the county, mainly the Keith, Colby, Holdrege, and Ulysses silt loams, formed in it.

The loess consists of uniform, fine-grained, calcareous sediments. It contains many small rootlets and vertical root holes that are lined or filled with calcium carbonate.

The loess is gray, yellow, or brown and ranges from a few inches to more than 60 feet in thickness. In exposed banks of the loess, weathering has formed vertical columns. The loess is believed to have come from areas to the north and west.

Colluvium.—Colluvium consists of mixed deposits of soil material near the base of slopes. In this county it is made up mainly of recent, deep deposits of loamy material near the base of hills that border major streams. The deposits have accumulated through soil creep, slides, and local wash. Colluvium is not a major source of parent material in the county, but it is the parent material of the Bridgeport and Bayard soils.

Alluvium.—Alluvium consists of silt, clay, sand, gravel, and soil material washed from higher areas and deposited by rivers and streams. In this county this material is on the flood plains of the Republican River and its main tributaries. Many areas that are already covered by alluvium receive fresh deposits of material from time to time. Most of the soils that formed in alluvium are young and lack clearly expressed horizons. They vary because of differences in the source of parent material. The soils formed in alluvium in this county are the Bankard, Barney, Glenberg, Haverson, Las, and McCook.

Climate

Climate influences formation of soils both directly and indirectly. It affects the weathering and reworking of parent material directly through rainfall, temperature, and wind. It affects the soils indirectly through the amount and kind of vegetation and animal life sustained.

The climate of Red Willow County varies widely both in temperature and precipitation. Below-zero temperatures in winter and temperatures of more than 100° F. in summer are common. The average annual precipitation is 20.42 inches, and the average annual temperature is approximately 52°. Most of the precipitation falls in summer. When moisture is sufficient, frost penetrates to a depth of 2 to 4 feet, and the soil stays frozen for about 3 months of the year.

The humidity is low. Wind velocities are high late in fall and during winter and spring. Droughts that last 1 to 3 months sometimes occur and affect the soils in several ways. Lack of moisture reduces chemical weathering and leaching, reduces or stops the growth of plants, and permits loss of fine particles of minerals and organic matter from cultivated soils that are not protected during periods of blowing. Thus, the combined effects of dry weather and blowing over a long period can change greatly the physical and chemical properties of the soils.

The total amount of precipitation in the county is not enough to leach the soils to any great extent. The free calcium in the soils tends to keep the colloidal clay granulated, and there is little downward movement of clay in the soil profile. Clay has accumulated in the upper part of the subsoil in a few areas near the east county line, and here the texture of the subsoil is silty clay loam. Climate also has been a dominant factor in formation of soils that have distinct horizons. Such soils have a thick, dark-colored, granular surface layer and free lime carbonates in the lower part of the subsoil or in the parent material.

Plants and animals

Trees and shrubs, grass, and other herbaceous plants, micro-organisms, earthworms, and other forms of plant and animal life on and in the soil are all active agencies in the soil-forming processes. The kinds of plants and animals that live on and in the soil are determined by environmental factors including climate, parent material, relief, age of the soil, and the associated organisms. The influence of climate is the most apparent in determining the kinds and amounts of plant and animal life. In this way climate exerts a strong influence on the formation of soils.

Short and mid grasses were the main vegetation in the county, but tall grasses grew in places. As a result of the growth of these grasses, the color, content of organic matter, and physical and chemical properties of the soils are affected. The fibrous roots of the grasses penetrate to a depth of 12 to 18 inches, and some of the smaller roots may go even deeper. Plant nutrients, mainly calcium, are brought to the surface by the roots and are returned to the surface layer through their stems and leaves as organic matter. This process of redistribution tends to keep the soil porous, contributes to favorable action of bacteria, and encourages activity of earthworms and small burrowing animals. Such activity and the accumulation of organic matter aid in soil development and make the soil granular.

Little water runs off the nearly level to gently sloping soils of the uplands, and they thus absorb most of the moisture that falls. Growth of grasses on such soils is generally excellent and favors interaction of plant and animal life. As a result, such soils are the darkest of any soils in the county. Runoff from steeper soils, however, is rapid, and little moisture is absorbed. Less grass grows on such soils, and therefore they are much lighter colored.

Well drained and moderately well drained soils that formed in alluvium produce larger amounts of native vege-

209-366—67——4

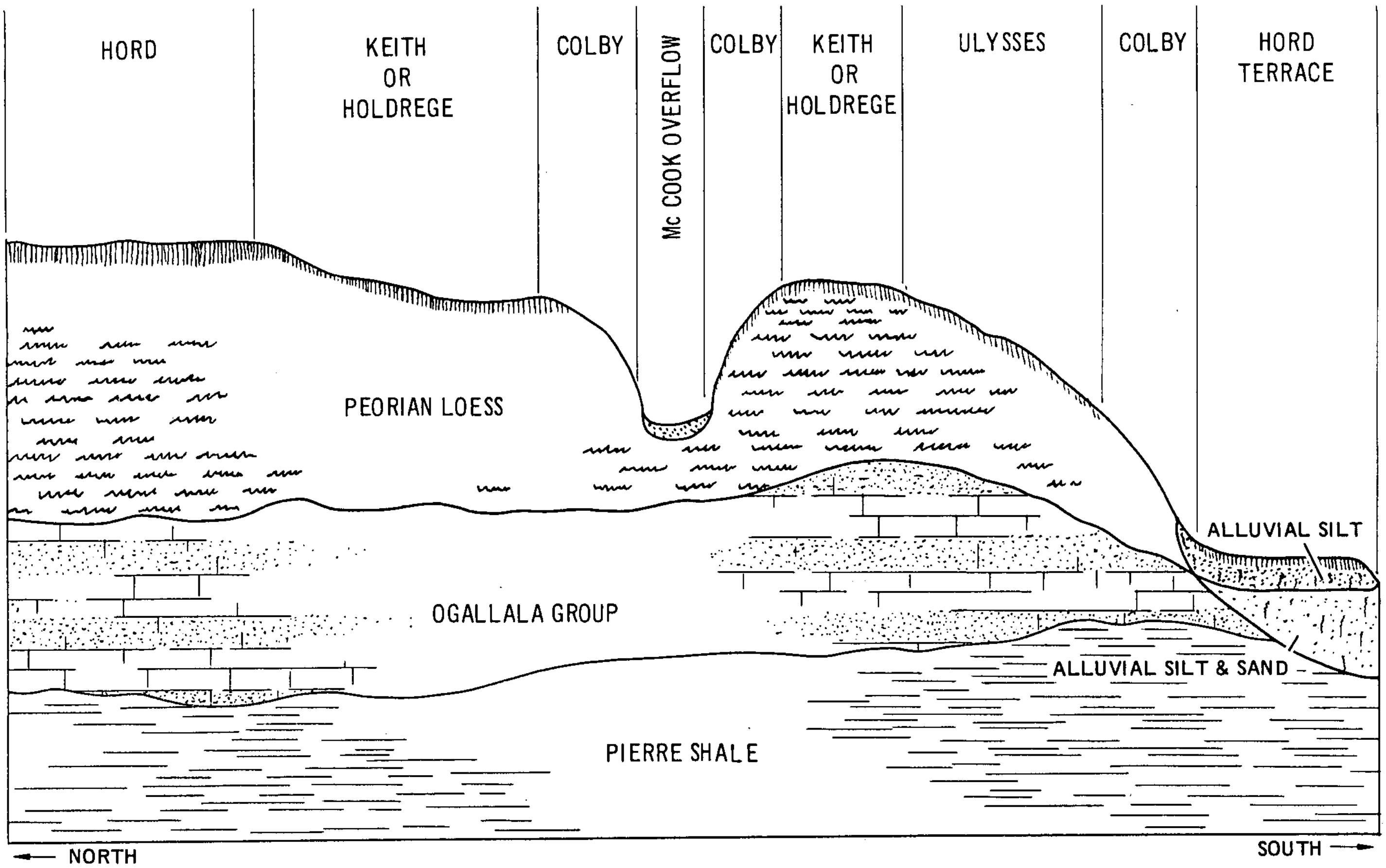


Figure 16.—**Cross section of Red Willow County, showing**

tation than soils of the uplands and therefore contain more organic matter. In time the surface layer of such soils becomes thick and dark, but soils forming in recent alluvium are rather light colored.

Man through his activity also affects formation of soils. He determines, by the kind of management he uses, whether the soil is conserved or is lost through erosion. Thus, man through the way he manages the land he cultivates, affects the direction and rate of soil formation in the future.

Relief

Relief influences formation of soils through its effect on drainage and runoff. Soils on strong slopes absorb much less moisture and have less well-developed profiles than soils on flats. On steep slopes the soil-forming processes are slowed because of continuous erosion. Lime is also at or near the surface because moisture intake is low, and consequently, less lime is leached from the soils.

Time

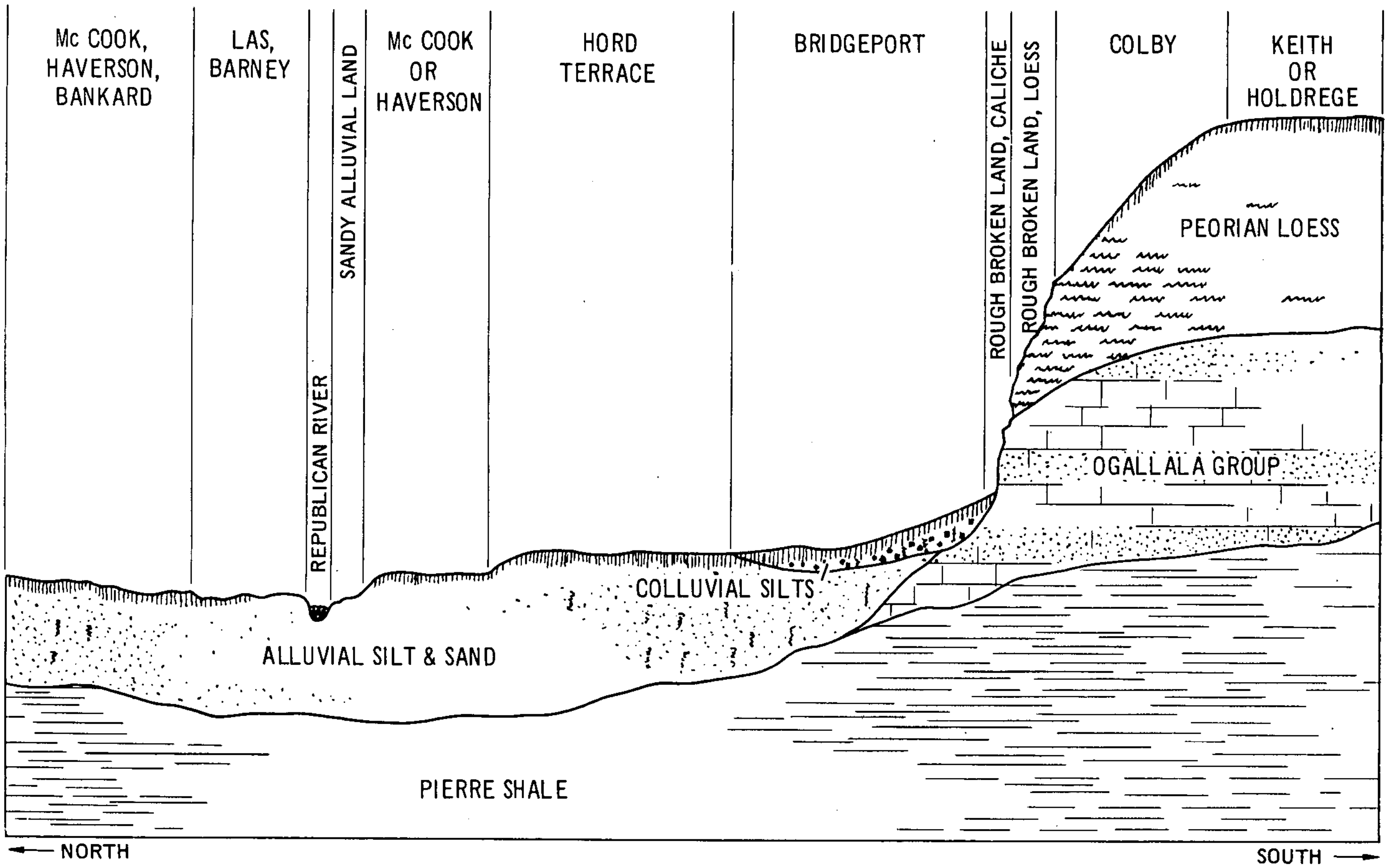
Time is necessary for formation of soils. The length of time needed depends on the kind of parent material and on the other factors involved. When the factors of soil formation have not operated long enough to form a soil that contains definite horizons, the soil is considered young, or immature. Soils that have been in place for a long time and have approached equilibrium with their environment tend to have well-expressed horizons and are considered mature.

The soils of Red Willow County range from young soils that show little or no development to soils that have fairly thick profiles and definite horizons. The soil materials on first bottoms or on fans or colluvial slopes have little or no horizon development. The soils here are immature, or young soils. Their horizons are few or weakly expressed because fresh material is continually being deposited on the areas. Examples of such soils are the Bridgeport and Haverson. Colby soils on steep slopes also are weakly developed. They have been in place long enough for horizons to form, but because of the slope, the soil material has been removed before well-expressed horizons could form.

Some soils in the county have been in place long enough to develop genetic profiles that have somewhat thick horizons. Examples of these are the Holdrege and Keith soils. In the nearly level areas of these soils are old buried soils. Formation of the buried soils took place many years before deposition of the material now on top of the old buried soils. Other soils in the county are intermediate in development between the well-developed Keith and Holdrege soils and the weakly developed Colby soils. The Ulysses soils are an example.

Classification of Soils

Soils are classified so that we may more easily remember their significant characteristics. Classification enables us



the relationship of the soils to the geological materials.

to assemble knowledge about soils, to see their relationships to one another and to the whole environment, and to develop principles that help us to understand their behavior and their response to manipulation. First, through classification, and then through the use of soil maps, we can apply our knowledge of soils to specific tracts or parcels of land.

Thus, in classification, soils are placed in narrow categories that are used in detailed soil surveys so that knowledge about the soils can be organized and applied in managing farms, fields, and woodlands; in developing suburbs; in engineering work; and in many other ways. Likewise, soils are placed in broad classes to facilitate study and comparison in large areas, such as countries and continents.

Two systems of natural classification of soils are now in general use in the United States. One of these is the 1938 system (*2*), with later revisions. The other, the current system (*4*), was placed in general use by the Soil Conservation Service in 1965.

The 1938 system, with later revisions, consists of six categories. In the highest of these, the soils of the whole country have been placed in three orders. The next two categories, the suborder and the family, have never been fully developed. As a consequence, they have not been used very much in the past. More attention has been centered on lower categories, the great soil group, the soil series, and the soil type. A further subdivision of the soil type, called the soil phase, has been clearly defined, along with soil type and soil series, in the section "How This Survey Was Made" in the front of this report.

Under the new system, the soils are also placed in six categories. They are, beginning with the most inclusive, the order, the suborder, the great soil group, the subgroup, the family, and the series. In this system the criteria used as a basis for classification are observable or measurable properties. The properties are so chosen, however, that soils of similar mode of origin are grouped together.

In table 7 each soil series of Red Willow County is placed in its family, subgroup, suborder, and order of the new classification system, and in its great soil group of the older system.

Orders—Ten soil orders are recognized. They are Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols. The properties used to differentiate the soil orders are those that tend to give broad climatic groupings of soils. The two exceptions to this are the Entisols and Histosols, which occur in many different climates.

Table 7 shows the two soil orders in Red Willow County—Entisols and Mollisols. Entisols are recent soils. They are without genetic horizons or have only the beginnings of such horizons. In Red Willow County this order includes many but not all of the soils that were formerly called Alluvial soils and Regosols.

TABLE 7.—*Classification of soil series*

Series	New classification				1938 system with later revisions
	Family	Subgroup	Suborder	Order	Great soil group
Bankard	Sandy, siliceous, mesic	Cumulic Normipsamment	Psamment	Entisol	Alluvial.
Barney	Sandy, mixed, mesic	Psammentic Haplaquoll	Aquoll	Mollisol	Alluvial.
Bayard	Coarse loamy, mixed, mesic	Entic Haplustoll	Ustoll	Mollisol	Alluvial.
Bridgeport	Fine silty, mixed, mesic	Entic Haplustoll	Ustoll	Mollisol	Alluvial.
Colby	Fine silty, mixed, calcareous, mesic	Typic Haplorthent	Orthent	Entisol	Regosol.
Glenberg	Coarse loamy, mixed, calcareous, mesic	Cumulic Haplorthent	Orthent	Entisol	Alluvial.
Haverson	Fine loamy, mixed, calcareous, mesic	Cumulic Haplorthent	Orthent	Entisol	Alluvial.
Holdrege	Fine silty, mixed, mesic	Typic Argiustoll	Ustoll	Mollisol	Chernozem.
Hord	Fine silty, mixed, mesic	Cumulic Haplustoll	Ustoll	Mollisol	Chernozem.
Keith	Fine silty, mixed, mesic	Typic Argiustoll	Ustoll	Mollisol	Chestnut.
Las	Fine loamy, mixed, calcareous, mesic	Aquic Cumulic Haplorthent	Orthent	Entisol	Alluvial.
McCook	Fine loamy, mixed, mesic	Entic Haplustoll	Ustoll	Mollisol	Alluvial.
Ulysses	Fine silty, mixed, mesic	Typic Haplustoll	Ustoll	Mollisol	Chestnut.

Mollisols are soils that have a thick surface layer that is dark, friable, and soft and contains more than 1 percent of organic matter. Most of them have formed under grass. In Red Willow County this order includes the soils formerly classified in the Chestnut and Chernozem great soil groups.

Suborders.—Each order is subdivided into suborders, primarily on the basis of those soil characteristics that seem to produce classes with the greatest genetic similarity. The suborders narrow the broad climatic range permitted in the orders. The soil properties used to separate suborders are mainly those that reflect either the presence or absence of waterlogging, or soil differences resulting from the climate or vegetation.

Great groups.—Soil suborders are separated into great groups on the basis of uniformity in the kinds and sequence of major soil horizons and features. The horizons used to make separations are those in which clay, iron, or humus have accumulated or those that have pans that interfere with growth of roots or movement of water. The features used are the self-mulching properties of clays, soil temperature, major differences in chemical composition (mainly calcium, magnesium, sodium, and potassium), and the like. The great group is not shown separately in table 7.

Subgroups.—Great groups are subdivided into subgroups, one representing the central (typic) segment of the group and others called intergrades that have properties of the group and also one or more properties of another great group, suborder, or order. Subgroups may also be made in those instances where soil properties intergrade outside of the range of any other great group, suborder, or order. The names of subgroups are derived by placing one or more adjectives before the name of the great group. An example is Typic Normipsamment (a typical Normipsamment).

Families.—Families are separated within a subgroup primarily on the basis of properties important to the growth of plants or behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence.

Series.—The series is a group of soils that have major horizons that, except for texture of surface layer, are similar in important characteristics and in arrangement in the profile. They are given the name of a geographic location near the place where that series was first observed and mapped. An example is the McCook series.

Detailed Descriptions of Soil Series

In this section the soil series are discussed and a representative profile is described for each. Data on mechanical and chemical analyses for some of the soils in this county are given in the soil survey reports of Dundy, Hall, and Hamilton Counties, Nebr. (*5, 6, 7*). These data are useful to soil scientists in classifying soils and in understanding the factors of soil formation. They are also helpful in estimating the water-holding capacity, hazard of wind erosion, and fertility, tilth, and other characteristics that affect soil management, as well as the cost. Data on reaction, electrical conductivity, and percentage of exchangeable sodium are helpful in evaluating the possibility of reclaiming and managing saline-alkali areas.

BANKARD SERIES

The Bankard series consists of sandy, light-colored, well-drained soils that formed in alluvium. These soils occur throughout the county in nearly level to low hummocky areas and on bottom lands along the Republican River. The areas are not extensive in Red Willow County.

Profile of Bankard fine sand in a pasture of native grass (0.15 mile west and 0.05 mile north of the southeast corner of sec. 10, T. 3 N., R. 27 W.):

A1—0 to 7 inches, light brownish-gray (10YR 6/2) fine sand, dark brown (10YR 4/3) when moist; weak, coarse, prismatic structure that breaks to weak, fine, granular; loose when dry and moist; calcareous; abrupt, smooth boundary.

AC—7 to 13 inches, pale-brown (10YR 6/3) fine sand, brown (10YR 5/3) when moist; single grain; loose when moist; calcareous; clear, smooth boundary.

C1—13 to 40 inches, very pale brown (10YR 7/3) fine sand, pale brown (10YR 6/3) when moist; single grain;

loose when dry and moist; noncalcareous; clear, smooth boundary.

IIC2—40 to 60 inches, coarse deposits of sand and gravel.

The surface layer ranges from fine sand to loamy fine sand. In a few places the coarse sand and gravel occur in the upper 36 inches. The water table is generally at a depth of more than 6 feet.

BARNEY SERIES

In the Barney series are shallow, poorly drained soils that formed in recent silty alluvium. The alluvium is 4 to 12 inches thick over fine sand or mixed sand and gravel. The soils have a water table within 2 feet from the surface, and they have much calcium carbonate in the upper part of the profile.

Profile of Barney silty clay loam (0.25 mile south and 0.4 mile west of the northeast corner of sec. 34, T. 3 N., R. 29 W.):

A1—0 to 6 inches, very dark gray (10YR 3/1 silty clay loam, black (10YR 2/1) when moist; moderate, fine, granular structure; slightly hard when dry, friable when moist; moderately calcareous; abrupt, smooth boundary.

C1—6 to 12 inches, pale-brown (10YR 6/3) fine sand, brown (10YR 5/3) when moist; single grain; loose when dry and moist; calcareous; gradual, wavy boundary.

IIC2—12 to 60 inches +, sand and gravel from the river.

BAYARD SERIES

In the Bayard series are nearly level to very gently sloping, moderately dark colored, moderately sandy, well-drained soils. These soils are on fans or colluvial foot slopes.

Profile of a Bayard fine sandy loam in a cultivated field (0.5 mile north and 0.1 mile east of the southwest corner of sec. 9, T. 3 N., R. 26 W.):

Ap—0 to 7 inches, grayish-brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft when dry, very friable when moist; noncalcareous; abrupt, smooth boundary.

A12—7 to 16 inches, dark grayish-brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, subangular blocky structure; soft when dry, very friable when moist; noncalcareous; abrupt, smooth boundary.

Cl—16 to 24 inches, grayish-brown (10YR 5/2) loamy sand, dark grayish brown (10YR 4/2) when moist; weak, coarse, prismatic structure; soft when dry, very friable when moist; calcareous; clear, smooth boundary.

C2—24 to 28 inches, light brownish-gray (10YR 6/2) fine sandy loam, dark grayish brown (10YR 4/2) when moist; weak, coarse, prismatic structure; soft when dry, very friable when moist; strongly calcareous; abrupt, smooth boundary.

Alb—28 to 35 inches, dark grayish-brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, prismatic structure; soft when dry, very friable when moist; strongly calcareous; abrupt, smooth boundary.

C—35 to 60 inches +, light brownish-gray (10YR 6/2) loamy fine sand, grayish brown (10YR 5/2) when moist; massive; loose when dry, very friable when moist; strongly calcareous.

The surface layer ranges from fine sandy loam to loamy fine sand. Depth to calcium carbonate ranges from 6 to 16 inches.

BRIDGEPORT SERIES

Bridgeport soils are nearly level to gently sloping, deep, moderately dark colored, and silty. These soils are on fans or colluvial foot slopes along the main streams of the county and the tributaries of these streams. They contain much calcium carbonate, and their profile characteristics are nearly uniform to a depth of 3 feet or more.

Profile of a Bridgeport silt loam in a cultivated field (0.4 mile west and 0.4 mile north of the southeast corner of sec. 17, T. 3 N., R. 28 W.):

Ap—0 to 6 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft when dry, very friable when moist; calcareous; abrupt, smooth boundary.

A12—6 to 12 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, prismatic structure that breaks to weak, medium and fine, granular; soft when dry, very friable when moist; calcareous; clear, smooth boundary.

AC—12 to 21 inches, grayish-brown (10YR 5/2) silt loam, dark grayish brown (10YR 4/2) when moist; weak, coarse, prismatic structure that breaks to weak, medium and fine, granular; soft when dry, very friable when moist; strongly calcareous; clear, smooth boundary.

C1—21 to 30 inches, light brownish-gray (10YR 6/2) silt loam, grayish brown (10YR 5/2) when moist; weak, fine, granular structure; soft when dry, very friable when moist; strongly calcareous; clear, smooth boundary.

C2—30 to 48 inches +, light-gray (10YR 7/2) silt loam, light brownish gray (10YR 6/2) when moist; massive; soft when dry, very friable when moist; strongly calcareous.

In some places the surface layer is dark grayish brown and an old buried soil is within 3 feet of the surface. The texture of the substratum ranges from silt loam to very fine sandy loam.

COLBY SERIES

The Colby series consists of light-colored, well-drained to excessively drained, silty soils that formed in Peorian loess. These soils are moderately sloping to strongly sloping and occur throughout the county. They are calcareous at or near the surface. The areas are extensive in Red Willow County.

Profile of a Colby silt loam in a pasture of native grass (0.1 mile east and 500 feet south of the northwest corner of sec. 19, T. 3 N., R. 28 W.):

A1—0 to 4 inches, grayish-brown (10YR 5/2) silt loam, dark grayish brown (10YR 4/2) when moist; weak, fine, granular structure; soft when dry, very friable when moist; calcareous; abrupt, smooth boundary.

AC—4 to 10 inches, grayish-brown to light brownish-gray (10YR 5.5/2) silt loam, dark grayish brown to grayish brown (10YR 4.5/2) when moist; weak, coarse, prismatic structure that breaks to weak, fine, granular; soft when dry, very friable when moist; strongly calcareous; gradual, smooth boundary.

C1—10 to 19 inches, light brownish-gray (10YR 6/2) silt loam, grayish brown (10YR 5/2) when moist; weak, coarse, prismatic structure; soft when dry, very friable when moist; strongly calcareous; gradual, smooth boundary.

C2—19 to 54 inches +, light-gray (10YR 7/2) silt loam, grayish brown to brown (10YR 5/2.5) when moist; massive; soft when dry, very friable when moist; strongly calcareous.

The upper 3 to 4 inches of these soils lacks calcium carbonate in places.

GLENBERG SERIES

In the Glenberg series are nearly level to very gently sloping, light-colored, moderately sandy, well-drained to somewhat poorly drained soils. These soils formed in recent alluvium on bottom lands along the Republican River. They contain much calcium carbonate.

Profile of Glenberg fine sandy loam in a pasture of native grass (0.25 mile west and 0.2 mile north of the southeast corner of sec. 26, T. 3 N., R. 29 W.):

A11—0 to 5 inches, light brownish-gray (10YR 6/2) fine sandy loam, dark grayish brown (10YR 4/2) when moist; weak, fine, granular structure; soft when dry, very friable when moist; calcareous; abrupt, smooth boundary.

A12—5 to 13 inches, grayish-brown (10YR 5/2) fine sandy loam, very dark grayish brown to dark grayish brown (10YR 3.5/2) when moist; weak, coarse, prismatic structure that breaks to weak, fine granular; soft when dry, very friable when moist; strongly calcareous; gradual, smooth boundary.

AC—13 to 36 inches, grayish-brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) when moist; weak, coarse, prismatic structure that breaks to weak, fine, granular; soft when dry, very friable when moist; strongly calcareous; gradual, smooth boundary.

C—36 to 60 inches +, pale-brown (10YR 6/3) fine sand, brown (10YR 5/3) when moist; single grain; loose when dry and moist; calcareous.

The surface layer ranges from loam to loamy fine sand. In places the somewhat poorly drained soils are slightly darker colored than the well-drained soils. Depth to the water table is more than 6 feet in the well-drained soils, but it ranges from 2 to 6 feet in the somewhat poorly drained soils.

HAVERSON SERIES

The Haverson series consists of deep, nearly level, light-colored, well-drained soils that have a silty subsoil. These soils occur throughout the county in low areas along major streams. They are calcareous throughout. The areas are widely scattered throughout the county.

Profile of Haverson fine sandy loam in a cultivated field (0.45 mile west and 0.15 mile south of the northeast corner of sec. 11, T. 3 N., R. 27 W.):

Ap—0 to 6 inches, dark grayish-brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft when dry, very friable when moist; calcareous; abrupt, smooth boundary.

A12—6 to 12 inches, grayish-brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) when moist; weak, medium, prismatic structure that breaks to weak, fine, granular; soft when dry, very friable when moist; moderately calcareous; clear, smooth boundary.

C—12 to 16 inches, light brownish-gray (10YR 6/2) loamy fine sand, grayish brown (10YR 5/2) when moist; weak, medium, prismatic structure that breaks to weak, fine, granular; soft when dry, very friable when moist; calcareous; abrupt, smooth boundary.

IIA1b—16 to 26 inches, very dark grayish-brown (10YR 3/2) silt loam, very dark brown (10YR 2/2) when moist; weak, coarse, prismatic structure that breaks to weak, medium and fine, subangular blocky; soft when dry, very friable when moist; moderately calcareous; clear, smooth boundary.

IIC1—26 to 32 inches, grayish-brown (10YR 5/2) silt loam, dark grayish brown (10YR 4/2) when moist; weak, coarse, prismatic structure that breaks to weak, medium and fine, subangular blocky; soft when dry, very friable when moist; strongly calcareous; clear, smooth boundary.

IIC2—32 to 38 inches, pale-brown (10YR 6/3) fine sandy loam, brown (10YR 5/3) when moist; weak, coarse, prismatic structure that breaks to weak, medium, subangular blocky; soft when dry, very friable when moist; strongly calcareous; clear, smooth boundary.

IIIC3—38 to 52 inches +, very pale brown (10YR 7/3) fine sand, pale brown (10YR 6/3) when moist; single grain; loose when dry and moist; calcareous.

The surface layer ranges from fine sandy loam to silt loam. The profile described has a thicker and more sandy surface layer than is characteristic for the series. An old buried soil occurs in many places at various depths. Coarse sediments from the river are at a depth of 3 to 6 feet.

HOLDREGE SERIES

In the Holdrege series are nearly level to gently sloping, moderately dark, well-drained, silty soils. These soils formed in the uplands in thick deposits of Peorian loess. They have a thick, dark surface layer and a subsoil that is moderately well developed. Holdrege soils are calcareous in the lower part of the subsoil or in the upper part of the substratum.

Profile of a Holdrege silt loam in a cultivated field (0.45 mile west and 0.4 mile south of the northeast corner of sec. 12, T. 3 N., R. 28 W.):

Ap—0 to 6 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft when dry, very friable when moist; noncalcareous; abrupt, smooth boundary.

A12—6 to 12 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, prismatic structure that breaks to weak, medium and fine, granular; soft when dry, very friable when moist; noncalcareous; clear, smooth boundary.

B21—12 to 17 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, prismatic structure that breaks to weak, medium and fine, subangular blocky; soft when dry, very friable when moist; noncalcareous; clear, smooth boundary.

B22t—17 to 23 inches, grayish-brown to light grayish-brown (10YR 5.5/2) heavy silt loam, dark grayish brown (10YR 4/2) when moist; moderate, coarse, prismatic structure that breaks to moderate, medium and fine, subangular blocky; soft when dry, very friable when moist; noncalcareous; clear, smooth boundary.

B3—23 to 29 inches, light brownish-gray (10YR 6/2) silt loam, grayish brown (10YR 5/2) when moist; weak, medium and fine, subangular blocky structure; noncalcareous; clear, smooth boundary.

C—29 to 48 inches +, light-gray (10YR 7/2) silt loam, light brownish gray (10YR 6/2) when moist; massive; soft when dry, very friable when moist; strongly calcareous.

The thickness of the surface layer ranges from 6 to 16 inches. In some areas the subsoil is nearly silty clay loam or is silt loam throughout and has weak to moderate structure. Depth to calcium carbonate ranges from 2 to 3 feet.

HORD SERIES

The Hord soils are dark, nearly level, well-drained, and silty. These soils are in the uplands and on stream terraces. They formed in loess, and their surface layer has been thickened by slow accumulation of recent loess. They have a thick, dark-colored surface layer overlying a subsoil that is slightly lighter colored and is weakly to moderately well developed. Hord soils contain calcium carbonate at a depth of 2 to 4 feet.

Profile of a Hord silt loam in a cultivated field (300 feet north and 50 feet west of the southeast corner of the NE¼ of sec. 31, T. 4 N., R. 26 W.):

Ap—0 to 5 inches, very dark grayish-brown (10YR 3/2) silt loam, very dark brown (10YR 2/2) when moist; weak, medium and fine, granular structure; soft when dry, very friable when moist; noncalcareous; abrupt, smooth boundary.

A11—5 to 10 inches, very dark grayish-brown (10YR 3/2) silt loam, very dark brown (10YR 2/2) when moist; weak, coarse, prismatic structure that breaks to weak, medium and fine, subangular blocky; soft when dry, very friable when moist; noncalcareous; abrupt, smooth boundary.

A12—10 to 14 inches, very dark grayish-brown (10YR 3/2) silt loam, black (10YR 2/1) when moist; weak, coarse, prismatic structure that breaks to weak, medium and fine, subangular blocky; soft when dry, very friable when moist; noncalcareous; abrupt, smooth boundary.

A3—14 to 23 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, prismatic structure that breaks to weak, medium and fine, subangular blocky; soft when dry, very friable when moist; noncalcareous; clear, smooth boundary.

B21—23 to 27 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, medium to fine, subangular blocky structure; soft when dry, very friable when moist; noncalcareous; gradual, smooth boundary.

B22—27 to 36 inches, grayish-brown (10YR 5/2) heavy silt loam, dark grayish brown to very dark brown (10YR 3.5/2) when moist; weak to moderate, coarse, prismatic structure that breaks to weak to moderate, medium and fine, subangular blocky; hard when dry, firm when moist; calcareous; clear, smooth boundary.

B3—36 to 42 inches, light brownish-gray (10YR 6/2) silt loam, dark brown (10YR 4/3) when moist; weak, medium and fine, subangular blocky structure; slightly hard when dry, friable when moist; strongly calcareous; gradual, smooth boundary.

C—42 to 60 inches, light-gray (10YR 7/2) silt loam brown (10YR 5/3) when moist; massive; soft when dry, very friable when moist; strongly calcareous.

The surface layer ranges from very dark grayish brown to dark grayish brown. The subsoil ranges from silt loam to heavy silt loam in texture. Its structure is weak to moderate. Depth to calcium carbonate ranges from 2 feet in the uplands to nearly 4 feet on the terraces.

KEITH SERIES

The Keith series consists of nearly level to gently sloping, moderately dark, well-drained, silty soils. These soils formed in the uplands in thick deposits of Peorian loess. They have a dark surface layer that is thick to moderately thick and a slightly lighter colored subsoil that is weakly to moderately well developed. Keith soils contain lime at a depth of about 2 feet.

Profile of a Keith silt loam in a cultivated field (0.10 mile south and 0.10 mile east of the northwest corner of sec. 7, T. 3 N., R. 28 W.):

Ap—0 to 6 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft when dry, very friable when moist; noncalcareous; abrupt, smooth boundary.

A1—6 to 13 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, prismatic structure that breaks to weak, medium and fine, granular; soft when dry, very friable when moist; noncalcareous; clear, smooth boundary.

B21—13 to 18 inches, dark grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, prismatic structure that breaks to weak, medium and fine, subangular blocky; soft when dry, very friable when moist; noncalcareous; clear, smooth boundary.

B22t—18 to 29 inches, brown (10YR 5/3) silt loam, dark brown (10YR 4/3) when moist; weak, coarse, prismatic structure that breaks to moderate, medium, subangular blocky; soft when dry, very friable when moist; noncalcareous; clear, smooth boundary.

B3—29 to 36 inches, light brownish-gray (10YR 6/2) silt loam, brown (10YR 5/3) when moist; weak, coarse, prismatic structure that breaks to weak, medium and fine, subangular blocky; soft when dry, very friable when moist; moderately calcareous; gradual, smooth boundary.

C—36 to 60 inches, light-gray (10YR 7/2) silt loam, pale brown (10YR 6/3) when moist; massive; soft when dry, very friable when moist; moderately calcareous.

The surface layer ranges from 6 to 16 inches in thickness, but it is generally 10 inches thick. Depth to calcium carbonate ranges from 20 to 30 inches. The profile described has a thicker solum than is characteristic of the series.

LAS SERIES

In the Las series are nearly level, light-colored, silty, somewhat poorly drained soils that formed in alluvium. These soils are in the lowlands along the Republican River. They are calcareous throughout. During the growing season the water table fluctuates, but it is generally 2 to 6 feet from the surface. Depth to underlying sand and gravel is about 3 feet.

Profile of Las loam in a pasture of native grass (0.4 mile north and 0.2 mile east of the southwest corner of sec. 35, T. 3 N., R. 30 W.):

A11—0 to 5 inches, grayish-brown (10YR 5/2) loam, dark grayish brown (10YR 4/2) when moist; weak, fine, granular structure; soft when dry, very friable when moist; strongly calcareous; abrupt, smooth boundary.

A12—5 to 11 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, prismatic structure that breaks to weak, medium and fine, subangular blocky; soft when dry, very friable when moist; strongly calcareous; clear, smooth boundary.

AC—11 to 20 inches, grayish-brown (10YR 5/2) very fine sandy loam, dark grayish brown (10YR 4/2) when moist; weak, coarse, prismatic structure that breaks to weak, medium and fine, subangular blocky; soft when dry, very friable when moist; strongly calcareous; clear, smooth boundary.

C1—20 to 25 inches, grayish-brown (10YR 5/2) silt loam, dark grayish brown (10YR 4/2) when moist; weak, coarse, prismatic structure that breaks to weak, medium and fine, subangular blocky; soft when dry, very friable when moist; strongly calcareous; abrupt, smooth boundary.

C2—25 to 34 inches, brown (10YR 5/3) fine sandy loam, dark brown (10YR 4/3) when moist; weak, medium, prismatic structure; soft when dry, very friable when moist; strongly calcareous; abrupt, smooth boundary.

IIC3—34 to 39 inches, pale-brown (10YR 6/3) fine sand, brown (10YR 5/3) when moist; single grain; soft when dry, very friable when moist; calcareous; clear, smooth boundary.

IIC4—39 to 48 inches +, deposits of sand and gravel from the river.

The surface layer ranges from loam to fine sand. Many stratified layers of dark- and light-colored materials are throughout the profile. Depth to the fluctuating water table ranges from 2 to 6 feet. In some areas the soils contain salt and alkali that are damaging to crops.

McCOOK SERIES

In the McCook series are nearly level, deep soils that formed in silty alluvium. These soils are on high bottom lands along the Republican River, Beaver Creek, and the main tributaries of these streams. They are among the most productive soils in the county.

Profile of a McCook loam in a cultivated field (250 feet east and 100 feet south of the center of sec. 34, T. 3 N., R. 30 W.):

Ap—0 to 6 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft when dry, very friable when moist; calcareous; abrupt, smooth boundary.

A1—6 to 15 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, prismatic structure that breaks to weak, medium and fine, granular; soft when dry, very friable when moist; calcareous; abrupt, smooth boundary.

AC—15 to 31 inches, light brownish-gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) when moist; weak, coarse, prismatic structure that breaks to weak, medium and fine, granular; soft when dry, very friable when moist; strongly calcareous; clear, smooth boundary.

C1—31 to 38 inches, light brownish-gray (10YR 6/2) loam, grayish brown (10YR 5/2) when moist; weak, very thin, platy structure in the upper part but massive in the lower part; soft when dry, very friable when moist; strongly calcareous; gradual, smooth boundary.

C2—38 to 60 inches, light-gray (10YR 7/2) very fine sandy loam, grayish brown (10YR 5/2) when moist; massive; soft when dry, very friable when moist; calcareous.

The surface layer ranges from loam to silt loam. In places thin strata of sand and gravel occur throughout the profile.

ULYSSES SERIES

Soils in the Ulysses series are gently sloping to moderately sloping, moderately dark, deep, silty, and well drained. These soils formed in the uplands in thick deposits of Peorian loess. The surface layer is moderately dark colored, and the subsoil is thin and weakly developed. In areas under native grass, the surface layer is free of lime. In cultivated areas plowing has mixed material from the subsoil with the surface layer, and here the surface soil is calcareous.

Profile of a Ulysses silt loam in a native grass pasture (0.2 mile south and 300 feet east of the northwest corner of sec. 16, T. 3 N., R. 30 W.):

A11—0 to 6 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft when dry, very friable when moist; noncalcareous; abrupt, smooth boundary.

A12—6 to 10 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, prismatic structure that breaks to weak, medium, subangular blocky; soft when dry, very friable when moist; calcareous; clear, smooth boundary.

B2—10 to 17 inches, grayish-brown (10YR 5/2) silt loam, dark grayish brown (10YR 5/2) when moist; weak, coarse and medium, subangular blocky structure; soft when dry, very friable when moist; moderately calcareous; clear, smooth boundary.

B3—17 to 26 inches, light brownish-gray (10YR 6/2) silt loam, grayish brown (10YR 5/2) when moist; weak, coarse and medium, subangular blocky structure; strongly calcareous; clear, smooth boundary.

C—26 to 48 inches +, light-gray (10YR 7/2) silt loam, light brownish gray (10YR 6/2) when moist; massive; soft when dry, very friable when moist; strongly calcareous.

The surface layer ranges from 4 to 10 inches in thickness. In cultivated areas the surface soil is calcareous.

General Nature of the County

This section provides general information about the relief and drainage of the county. It also gives facts about the climate, water supply, settlement and development, transportation and markets, and agriculture. The statistics used are mainly from reports of the U.S. Bureau of the Census.

Relief and Drainage

Red Willow County is in the western part of the Loess Plains, a part of the Great Plains. It consists of nearly level to gently sloping tablelands, the fringes of which are dissected by the valleys of the Republican River and by those of Driftwood, Red Willow, and Beaver Creeks and a few smaller streams.

The largest area of the uplands lies across the south-central part of the county, south of the Republican River valley and north of Beaver Creek. The tablelands here are very gently sloping but drop abruptly to the stream valleys and deeply entrenched ravines. The channels at the heads of many of the tributary drainageways are steep sided but shallow and in their lower courses break into ravines that are deep and gullied.

The valley of the Republican River is deeply entrenched. It is 2 to 2½ miles wide. The bottom land lies only 5 to 10 feet above the normal water level. Bordering the river are extensive alluvial terraces. These terraces are high above overflow from the river and are as much as 1½ to 2 miles wide in places.

Most of the county is drained by the Republican River, which flows through the central part of the county from west to east. It drains about 500 square miles of the county, and Beaver Creek drains much of the rest. About 8 square miles in the northeastern corner of the county, however, is drained by Medicine Creek, and about 3 square miles in the southeastern corner is drained by tributaries of Sappa Creek.

Because of the many streams that drain the county, drainage is good in most areas. An area about 8 miles northwest of McCook, however, is not drained by any stream. This area covers about 4 square miles. The surface is nearly level but has a few depressions.

Climate [6]

Red Willow County is along the southern border of Nebraska, and the western side of the county is about 65 miles from the Colorado border. Elevations range from about 2,300 feet, in the eastern part of the county in the valleys of the Republican River and Beaver Creek, to a little more than 2,800 feet, in the northwestern and southwestern corners. The valleys are several miles wide and are fairly flat. The adjacent uplands are rolling and are generally 100 feet or more above the valley floors.

The Rocky Mountains to the west of the county cut off any moisture that might enter the area from the west. There are no barriers to the north or south of the county. As a result, the county is subject to sharp changes in

[6] By RICHARD M. MYERS, State climatologist, U.S. Weather Bureau.

temperature when the wind shifts from south to north or from north to south. Changes in temperature are more noticeable in winter than in summer when the region to the north is too warm to provide much cold air.

Climate data for the county are summarized in tables 8, 9, and 10. The data given are based on averages of weather records at McCook, in Red Willow County, but some of the data in table 8 are from weather records at Culbertson across the boundary in Hitchcock County.

In winter cold weather generally alternates with warm periods. As a rule the temperature remains below freezing during only a few days each month. Although moderately cold anticyclones from the North Pacific region and the plateau region of the West frequently pass over the area, many of the cold air masses from northern Canada and the Arctic reach too far east of the county to greatly affect the weather. The average temperature in Red Willow County is therefore higher than in the northern and eastern parts of Nebraska. Cold air occasionally moves into this region, however, and remains for a month or more. The coldest month, as recorded at McCook, was January 1940, when the average temperature was only 13.3° F. This was 15° colder than the long-term average for this month.

Precipitation in winter is in the form of light, rather infrequent snows (table 8) that generally stay on the ground only a few days. The amount of snowfall increases throughout winter to a maximum in March. In most

TABLE 8.—*Temperature and precipitation, Red Willow County, Nebr.*

Month	Temperature [1]				Precipitation				
	Average daily maximum	Average daily minimum	Two years in 10 will have at least 4 days with—		Average monthly total [1]	One year in 10 will have—		Days with snow cover [3]	Average depth of snow on days with snow cover [3]
			Maximum temperature equal to or higher than—	Minimum temperature equal to or lower than—		Less than [2]—	More than [2]—		
	°F.	°F.	°F.	°F.	*Inches*	*Inches*	*Inches*	*Number*	*Inches*
January	41.0	14.6	62	—4	0.50	0	1.10	14	3.4
February	46.6	19.4	68	0	.58	.16	1.46	8	2.7
March	54.2	25.6	77	8	1.36	.05	2.29	6	6.5
April	66.2	37.5	84	23	2.14	.36	3.94	(4)	2.8
May	75.6	47.9	92	37	3.20	.80	6.17	0	0
June	85.8	58.0	100	46	3.22	1.19	4.01	0	0
July	92.7	63.9	104	54	3.00	.82	6.84	0	0
August	90.6	62.2	102	53	2.30	1.14	4.49	0	0
September	81.8	51.8	97	39	1.68	.24	3.78	0	0
October	70.4	39.5	87	26	1.15	.12	2.68	(4)	1.0
November	54.2	25.8	72	10	.77	(5)	1.97	4	3.5
December	44.3	19.5	63	4	.52	.05	1.30	10	2.7
Year	67.0	38.8	[6] 106	[7] —13	20.42	13.58	26.02	43	3.2

[1] Data from McCook, Red Willow County, 1930–59.
[2] Data from McCook, 1882–90.
[3] Data from Culbertson, Hitchcock County, 1943–60.
[4] Less than 1 day.
[5] Trace.
[6] Average annual highest maximum.
[7] Average annual lowest minimum.

TABLE 9.—*Probabilities of last freezing temperatures in spring and first in fall*

Probability	Dates for given probability and temperature				
	16° F.	20° F.	24° F.	28° F.	32° F.
Spring:					
1 year in 10, later than	April 8	April 16	April 27	May 10	May 21.
2 years in 10, later than	April 3	April 11	April 22	May 4	May 15.
5 years in 10, later than	March 23	March 31	April 11	April 23	May 5.
Fall:					
1 year in 10, earlier than	October 24	October 19	October 14	September 29	September 20.
2 years in 10, earlier than	October 29	October 24	October 19	October 5	September 25.
5 years in 10, earlier than	November 9	November 3	October 29	October 15	October 5.

TABLE 10.—*Temperature and precipitation extremes at McCook, Nebr.*

Month	Temperature				Precipitation [2]			
	Highest	Year	Lowest	Year	Driest	Year	Wettest	Year
January	78	1911	−30	1912	0	1953 [3]	2. 36	1944
February	83	1933 [3]	−38	1899	0	1910	2. 63	1960
March	93	1943	−17	1943	0	1910	3. 99	1940
April	98	1939 [3]	0	1936	0	1924	8. 22	1944
May	104	1927	14	1909	0	1912	7. 39	1923
June	112	1933	35	1917	. 18	1924	8. 55	1915
July	114	1932	43	1922 [3]	. 40	1901	10. 86	1905
August	111	1930	39	1928 [3]	. 34	1928	6. 95	1925
September	107	1929	22	1912	. 07	1944	5. 76	1941
October	98	1928	−1	1913	0	1933	7. 62	1946
November	86	1931	−11	1940	0	1932 [3]	2. 98	1953
December	78	1939	−25	1919	0	1928 [3]	3. 19	1913
Year	114	1932	−38	1899	8. 74	1894	38. 26	1930

[1] Data on record for 60 years, during period 1892–1960.
[2] Data on record during period 1882–1960.
[3] Also in earlier years.

winters the weather favors outdoor activities by farmers and cattlemen. Cattle get much of their feed from cured range or pasture grasses, cornstalks, and sorghum stubble until after the first of the year. Winter wheat sometimes grows enough to be pastured, especially during the early part of winter and at the end of the season.

In the latter part of March, temperatures rise so that most of the precipitation falls as rain, although heavy snows occasionally occur in April, and light snows in May. Early in spring most of the rain is therefore part of rainstorms that cover a large area, and the fall of the rain is fairly slow and gentle. As spring advances much of the rain comes during thunderstorms that are severe at times. Some thunderstorms are accompanied by wind, hail, or occasionally by tornadoes. There is generally enough good weather in spring for farmers to plant their crops and to cultivate them. In most years there are periods in March when the weather is warm enough for plants to start growing. Such periods are followed by sharp changes to freezing temperature. The changeable temperature late in spring prevents the growing of any but the hardiest varieties of fruit. Frequent strong winds that come in spring also make pollenization of fruit difficult.

The number of thunderstorms is highest in June. These storms are occasionally accompanied by severe hailstorms, which sometimes damage crops. Hailstorms in June are particularly damaging to winter wheat, since the wheat is headed and filling out at this time. Precipitation begins to diminish by July because moist air currents from the Gulf start to move in a more northeasterly direction and generally pass to the east of the county.

In many years the summer weather is hot and is unfavorable for crops. If hot winds occur during the growing season when corn is tasseling and pollenizing is taking place, many of the tassels are killed and the ears of corn do not fill out. The low humidity and rapid evaporation in July encourage the harvest of wheat. About the middle of July after the wheat is harvested, much of the ground is left without cover other than stubble, which leaves the soil open to the hot rays of the sun. Grain sorghum, however, is quite resistant to hot summer weather, and increasingly large acreages are grown. In July temperatures in the afternoon are generally more than 100° for a few days each summer, but they are generally in the 90's. The hottest July on record at McCook was in 1901 when the average temperature was 86.2°.

Autumn begins a little later in Red Willow County than in the northern part of the State. Hot winds are frequent in early September but occasionally occur as late as early in October. Autumn, after the middle of September, is generally pleasant. Days are warm and bright, nights are fairly crisp, and winds are gentle. Precipitation is generally enough to start growth of winter wheat, and the short days and light winds greatly reduce evaporation.

The first freezing temperature in the county can be expected late in September. In most years, however, frost is delayed until early in October (table 9). The growing season is therefore generally long enough for corn and sorghum to reach maturity, unless the spring was wet and planting was delayed. The dry weather cures the range and pasture grasses and thus encourages harvesting of fall crops. In November the days are mostly mild and the nights are frosty. Freezes that are hard enough to damage crops occur a few times in November nearly every year.

Prevailing winds are from the northwest during January and through March, and from the southeast in April through September, but from the southwest in October, from the northwest in November, and from the west in December. The annual average velocity is about 10 to 12 miles per hour. The highest averages, about 13 to 14 miles per hour, are in March, April, and May. Occasionally strong winds with gusts as high as 100 miles per hour are associated with severe thunderstorms and squalls. Such winds cause damage to crops, trees, buildings, and powerlines, mainly during spring and early in summer. Winter blizzards, accompanied by high winds, pile the snow into large drifts that interfere with traffic and communications. Strong winds also cause considerable dust blowing during droughts.

In the following list are monthly amounts of potential evapotranspiration, in inches, as computed by the Thornthwaite method from mean temperatures at McCook, for

the period 1930 through 1959. December and January are not included, because the mean temperature in those months is below 32 degrees.

	Inches		Inches
February	0.04	July	6.47
March	0.49	August	5.62
April	1.76	September	3.51
May	3.41	October	1.86
June	5.14	November	0.39

The following are monthly averages of pan evaporation, in inches, that were computed for the period 1952–60 from the data at Medicine Creek Dam, outside the northeastern corner of Red Willow County.

	Inches		Inches
April	6.97	August	11.11
May	8.47	September	9.48
June	11.06	October	5.88
July	12.22		

Water Supply

Water supplies are adequate throughout most of the county. On the uplands a sandy deposit underlying the deposits of loess is the chief source of water. Excellent water is also obtained from wells that tap this source at a depth of 100 to 300 feet. The wells average from 140 to 160 feet in depth. On the bottom lands the underlying material is alluvial sand, and it provides an excellent source of water. Wells on the flood plains range from 8 to 15 feet deep in Red Willow Creek valley and from 15 to 30 feet deep in the Republican River valley. The wells on the terraces range from 20 to 30 feet deep.

Water for some crops is provided by irrigation. The first irrigation district in Red Willow County was organized in 1912 and irrigated 2,930 acres from the Meeker Canal for about 45 years. In 1946 the Frenchman-Cambridge District was organized. This district will irrigate 18,200 acres when the Red Willow Reservoir and Canal are completed. In the Hitchcock-Red Willow Irrigation District are 9,465 acres. Most of this acreage is part of the tablelands north and west of McCook. When all the canals in Red Willow County are completed, the total irrigated area in the county will be 27,665 acres.

Settlement and Development

The first permanent settlement in Red Willow County was made in the spring of 1872, near the present site of Indianola. The area was organized as a county a year later. In 1879 the Chicago, Burlington & Quincy Railroad constructed a line through the county, and additional settlers soon arrived. When the Kincaid Act was passed, which increased the amount of land that could be acquired by a homesteader to 640 acres, it became profitable for settlers to add to their holdings by purchasing land for grazing. As a result, the family economy increased and new settlers were attracted to the county.

In 1880 the population of Red Willow County was all rural and numbered 3,044. The population of the county increased to 12,940 in 1960, and about one-third of this was classed as rural; the rest was classed as urban.

In 1944 a rural electrification program was started in the county, and by 1959 most of the farms had telephones and electricity. The county had 18 consolidated schools. Churches of most denominations are available in the county. A hospital, radio station, and junior college are at McCook.

Production of oil has increased rapidly in the county since 1960. The yield per well ranges from less than 50 barrels a day to more than 200. Two productive oilfields are Ackerman Field, southwest of Indianola, and Sleepy Hollow Field, south of Bartley.

Transportation and Markets

Railroad transportation for the county is provided by the main line of the Chicago, Burlington & Quincy Railroad. This line follows the valley of the Republican River through the county and provides a direct route to Chicago, Lincoln, and Denver. The towns of McCook, Indianola, and Bartley are located along this line. A branch line of the same railroad passes through Beaver Creek valley, in the southeastern part of the county, and connects the towns of Lebanon, Danbury, and Marion. Most areas in the county are less than 10 miles from a shipping point.

U.S. Highways Nos. 6 and 34 cross the county by way of the valley of the Republican River. U.S. Highway No. 83 crosses the county from north to south through the town of McCook.

Agriculture

The agriculture of Red Willow County is based mainly on the growing of wheat and corn as cash crops, but production of livestock is also important.

About 75 percent of the acreage now cultivated was first plowed in the years between 1883 and 1910. In 1959, reports of the U.S. Bureau of the Census show that there were 764 farms in the county and the average size of each farm was 586.8 acres.

The acreage of the principal crops grown in the county in 1959, according to the U.S. Census of Agriculture, were as follows:

	Acres
Corn for all purposes	52,120
Sorghum	32,913
Wheat	53,732
Alfalfa	7,122
Barley	5,601

Of the total acreages in corn and alfalfa, 6,596 acres of corn and 452 acres of alfalfa, respectively, were irrigated. More than 26,000 acres of the sorghum grown in the county was harvested for grain or seed. The remaining acreage in sorghum included 1,937 acres cut for silage and 4,546 acres that was hogged or grazed, or cut for dry forage or hay. In addition, wild hay was cut from 48,702 acres. The total acreage in cultivated summer fallow was 78,431.

Livestock in Red Willow County consist mainly of cattle. Although production of cattle in the county fluctuates with demand, the number is generally increasing. The number of hogs, sheep, and horses, however, has decreased during the past 20 years.

Literature Cited

(1) AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS.
1961. STANDARD SPECIFICATIONS FOR HIGHWAY MATERIALS AND METHODS OF SAMPLING AND TESTING. Ed. 8, 2 pts., illus.

(2) BALDWIN, M., KELLOGG, C. E., AND THORP, J.
1938. SOIL CLASSIFICATION. U.S. Dept. Agr. Ybk., pp. 979–1001, illus.
(3) DYKSTERHUIS, E. J.
1958. RANGE CONSERVATION AS BASED ON SITES AND CONDITION CLASSES. Jour. Soil and Water Conserv. 13: 151–155, illus.
(4) SOIL SURVEY STAFF.
1960. SOIL CLASSIFICATION, A COMPREHENSIVE SYSTEM, 7TH APPROXIMATION AS AMENDED JUNE, 1964. USDA Soil Cons. Serv., 265 pp., illus.
(5) UNITED STATES DEPARTMENT OF AGRICULTURE.
1927. SOIL SURVEY, HAMILTON COUNTY, NEBR. Series 1927, No. 10, 26 pp., illus.
(6) ———
1962. SOIL SURVEY, HALL COUNTY, NEBR. Series 1957, No. 12, 141 pp., illus.
(7) ———
1963. SOIL SURVEY, DUNDY COUNTY, NEBR. Series 1959, No. 20, 86 pp., illus.
(8) WATERWAYS EXPERIMENT STATION, CORPS OF ENGINEERS.
1953. THE UNIFIED SOIL CLASSIFICATION SYSTEM. Tech. Memo. No. 3–357, v. 1.

Glossary

Aggregate (soil). A single mass or cluster that consists of many primary soil particles, such as a block or prism. See Structure, soil.

Alkali soil. A soil that has such a high content of salts, exchangeable sodium, or both, that the growth of most crops is reduced. In popular usage, saline soils are often called "white alkali," and the truly alkaline soils, those that contain exchangeable sodium, are called "black alkali." See Saline soil.

Alluvium. Sediments consisting of sand, silt, and clay that have been deposited by streams.

Bottom land. The normal flood plain of a stream, part of which may be flooded infrequently.

Calcareous soil. A soil that contains enough calcium carbonate, or magnesium carbonate, that it will fizz, or form bubbles, when treated with dilute hydrochloric acid. A soil that is alkaline in reaction because it contains free calcium carbonate.

Caliche. A term for more or less cemented deposits of calcium carbonate.

Clay. Soil grains less than 0.002 millimeter in diameter; or, as a textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Catsteps. Very small, irregular terraces on steep hillsides, especially in pastures, formed by cattle tracks or slippage of saturated soil.

Colluvium. Mixed deposits of soil material and rock fragments accumulated at the base of rather steep slopes through the influence of gravity, and, in some instances, assisted by flow of water.

Complex (soil). An intricate mixture of areas of at least two different kinds of soil that are too small to be shown separately on maps of the scale used and are, therefore, placed in one mapping unit.

Concretions. Rounded and hardened concretions of chemical compounds, such as calcium carbonate or iron oxides, often formed as concentric rings about a central particle, in the form of hard grains.

Consistence, soil. The combination of properties of a soil material that determine its resistance to crushing and its ability to be molded or changed in shape. Consistence varies with difference in moisture content; thus, a soil aggregate or clod may be hard when dry and plastic when wet. Terms used to describe consistence are—

Friable.—When moist, soil material crushes easily under gentle to moderate pressure between thumb and forefinger and coheres when pressed together. Friable soils are easily tilled.

Firm.—When moist, soil material crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable. Firm soils are likely to be difficult to till.

Hard.—When dry, soil material is moderately resistant to pressure; can be broken in the hands without difficulty but is barely breakable between thumb and forefinger.

Indurated.—Soil material is hard and brittle; will not soften when moisture is applied.

Loose.—Soil material is noncoherent when moist or dry. Loose soils are generally coarse textured and are easy to till.

Plastic.—When wet, soil material retains an impressed shape but is deformed by moderate pressure. Plastic soils are high in clay and are difficult to till.

Sticky.—When wet, soil material adheres to thumb and forefinger when pressed; normally very cohesive when dry.

Soft.—Soil material very weakly coherent and fragile; when dry, breaks to powder or to grains under slight pressure.

Dispersion (soil). The breaking down of soil aggregates into individual particles of clay, silt, or sand.

Eolian. Carried or produced by wind; for example, eolian sand.

Erosion (soil). The removal of soil material by geologic agencies, principally wind and water. *Accelerated erosion* refers to loss of soil material brought about mainly by the activities of man and is of three main types—*rill erosion*, *gully erosion*, and *sheet erosion*. Soil blowing, or wind erosion, is also a form of accelerated erosion.

Forb. Any herbaceous plant, neither a grass nor a sedge, that is grazed on western ranges.

Horizon, soil. A layer of soil, approximately parallel to the soil surface, that has characteristics produced by the soil-forming processes. Horizons are identified by letters of the alphabet, as follows:

A horizon. The horizon at the surface that has lost soluble minerals and clay through the action of percolating waters, or has a dark color because of accumulation of organic matter, or shows evidence of both translocation of materials and accumulation of organic matter. The A horizon may be divided into several layers, for example, A1, A2, and A3. An Ap horizon is the part of the A horizon that has been disturbed by cultivation or wind.

B horizon. The horizon where clay or other material has accumulated, where natural structural aggregates are present, or both. This horizon may be subdivided; for example, B1, B2, B3.

C horizon. The material immediately under the true soil, or solum. In chemical, physical, and mineral composition, this layer is presumed to be similar to the material from which at least part of the overlying soil developed.

Hummocky. Pertains to a landscape in which there are hillocks having little or no top, steep side slopes, and low sags between the hillocks. Rolling or undulating relief resembles hummocky relief but has broader ridgetops and longer, more even side slopes.

Infiltration (soil). Downward movement of water through the immediate surface of the soil.

Internal drainage (soil). Movement of water through the soil profile. Relative terms used to express rate of movement are *none*, *very slow*, *slow*, *medium*, *rapid*, and *very rapid*.

Leaching. The removal of soluble constituents, such as clay and organic matter, from soils by percolating water.

Loess. Geological deposit consisting of fairly uniform, fine material, mostly silt, that presumably was transported by wind.

Morphology (soil). The physical constitution of the soil, expressed in the kinds of soil horizons, their thickness and arrangement in the profile, and the texture, structure, consistence, porosity, and color of each horizon.

Mottling (soil). Patches of a color contrasting to that of the rest of the soil material. Mottles are described according to contrast (*faint*, *distinct*, and *prominent*); abundance (*few*, *common*, and *many*); and size (*fine*, *medium*, and *coarse*). Mottling normally indicates impeded drainage.

Ogallala formation. Water-bearing geologic formation that underlies the High Plains; extends to a depth of a few feet to several hundred feet; consists of alluvial outwash of the Pliocene epoch. Formation consists of alternating beds of gravel, sand, and silt, which are cemented with calcium carbonate. The degree of cementation varies.

Parent material. The unconsolidated material from which the soil develops; the C horizon.

Percolation. The downward movement of water through a porous substance, such as soil.

Pierre shale. Grayish geologic formation consisting of bedded shale; underlies the Ogallala formation and extends to a depth of several hundred feet; consists of sediments deposited in the seas during the Cretaceous geologic period.

Reaction (soil). The degree of acidity or alkalinity of the soil, expressed in pH values or in words. A pH of 7.0 indicates precise neutrality, one of less than 7.0 indicates acidity, and one of more than 7.0 indicates alkalinity.

Relief. Elevations or inequalities of the land surface considered collectively.

Saline-alkali soil. A soil that contains soluble salts and is highly alkaline or contains exchangeable sodium in such amounts as to reduce the growth of most crops. Saline-alkali soils look like saline soils so long as the amount of salts exceeds the amount of alkali (sodium). If the excess salts are removed, the sodium reacts with the clay colloids. The clay in the soil then disperses and swells and the soil becomes difficult to irrigate or manage for crops.

Saline soil. A soil that contains excess soluble salts, so distributed in the profile as to interfere with the growth of most crops.

Sand. Small rock or mineral fragments having diameters of 0.05 millimeter to 2.0 millimeters. Also, the textural name of a soil that contains more than 85 percent of sand and not more than 10 percent of clay.

Series (soil classification). A group of soils that, except for texture of the surface layer, have genetic horizons similar, as to differentiating characteristics and arrangement in the soil profile, and developed from a particular type of parent material.

Silt. Individual mineral particles in a soil that range in diameter between the upper size of clay, 0.002 millimeter, and the lower size of very fine sand, 0.05 millimeter. Soil of the textural class called silt contains 80 percent or more of silt and less than 12 percent of clay.

Slick spots. Small areas in a field that are slick when wet because they contain excess exchangeable sodium, or alkali.

Slope. The inclination of the land surface from the horizontal; percentage of slope is the vertical distance, divided by horizontal distance, times 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Soil. The natural medium for the growth of land plants. A natural, three-dimensional body on the surface of the earth, unlike the adjoining bodies. In this report "soil" is frequently used as a term equivalent to "mapping unit."

Solum. The part of the soil profile above the parent material; ordinarily, the A and B horizons, or the surface soil and subsoil.

Structure, soil. The arrangement of individual soil particles into lumps, granules, or other aggregates. Following are terms for shape of soil structure:

Blocky, angular.—Aggregates shaped like blocks; surfaces join at sharp angles.

Blocky, subangular.—Aggregates have some rounded and some flat surfaces; vertices, or corners, are rounded.

Columnar.—Aggregates are prismatic and are rounded at the upper end.

Crumb.—Generally soft, small, porous aggregates, irregular in shape but tending toward spherical.

Granular.—Roughly spherical, firm, small aggregates that may be either hard or soft but generally are more firm than those having crumb structure; no distinct faces such as those of blocky structure.

Platy.—Soil particles arranged around a plane, usually a horizontal plane; platelike.

Prismatic.—Soil particles arranged around a vertical plane and having flat vertical surfaces; platelike.

Substratum. Any layer beneath the solum, or true soil.

Terrace, level. An earth embankment, or ridge and channel, constructed across the slope at a suitable spacing and with an acceptable grade.

Tilth. The condition of the soil in terms of its relation to growing a plant or sequence of plants. A soil in good tilth is friable and porous and has stable, granular structure; a soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Type (soil classification). A subdivision of the soil series based on texture of the surface layer.

Winnowed. Sifted and sorted by wind. Strong winds remove clay, fine silt, and organic material from the soil and leave the coarser particles; consequently, the soil becomes sandier and more easily eroded.

GUIDE TO MAPPING UNITS

[See table 1, p. 5, for approximate acreage and proportionate extent of the soils and table 2, p. 20, for predicted yields on cultivated soils. For information significant to engineering, see section beginning on p. 26]

Map symbol	Mapping unit	Described on page	Capability unit: Symbol	Capability unit: Page	Range site: Name	Range site: Page
Bb	Bankard fine sand	5	VIe–5, Dryland	19	Sands	22
Bc	Bankard loamy fine sand	5	IIIe–5, Dryland or Irrigated	18	Sands	22
BCa	Rough broken land, caliche	12	VIIs–3, Dryland	20	Thin Breaks	23
Bf	Bayard fine sandy loam, 0 to 1 percent slopes.	6	IIe–3, Dryland or Irrigated	15	Sandy	22
BfA	Bayard fine sandy loam, 1 to 3 percent slopes.	6	IIIe–3, Dryland; IIe–3, Irrigated.	17	Sandy	22
2Bk	Bayard loam, slightly wet	6	IIw–4, Dryland or Irrigated	16	Subirrigated	22
BL	Rough broken land, loess	12	VIIe–1, Dryland	19	Thin Loess	23
Bn	Barney silty clay loam	6	Vw–1, Dryland	19	Wetland	22
Br	Bridgeport silt loam, 0 to 1 percent slopes.	6	IIc–1, Dryland; I–1, Irrigated	17	Silty	22
BrA	Bridgeport silt loam, 1 to 3 percent slopes.	6	IIe–1, Dryland or Irrigated	15	Silty	22
BrB	Bridgeport silt loam, 3 to 6 percent slopes.	7	IIIe–1, Dryland or Irrigated	17	Silty	22
CbCW	Colby silt loam, 3 to 9 percent slopes	7	IVe–8, Dryland	18	Thin Silty	23
CbDW	Colby silt loam, 9 to 30 percent slopes	7	VIe–9, Dryland	19	Thin Silty	23
Gd	Glenberg fine sandy loam	8	IIe–3, Dryland or Irrigated	15	Sandy	22
2Gd	Glenberg fine sandy loam, slightly wet	8	IIw–6, Dryland or Irrigated	17	Subirrigated	22
GK	Glenberg loam	8	I–1, Dryland or Irrigated	15	Silty	22
Hd	Hord silt loam, 0 to 1 percent slopes	10	IIc–1, Dryland; I–1, Irrigated	17	Silty	22
2Hd	Hord silt loam, terrace, 0 to 1 percent slopes.	10	IIc–1, Dryland; I–1, Irrigated	17	Silty	22
2HdA	Hord silt loam, terrace, 1 to 3 percent slopes.	10	IIe–1, Dryland or Irrigated	15	Silty	22
Hf	Haverson fine sandy loam	8	IIe–3, Dryland or Irrigated	15	Sandy	22
HK	Holdrege and Keith silt loams, 0 to 1 percent slopes.	9	IIc–1, Dryland; I–1, Irrigated	17	Silty	22
HKA	Holdrege and Keith silt loams, 1 to 3 percent slopes.	9	IIe–1, Dryland or Irrigated	15	Silty	22
HKA2	Holdrege and Keith silt loams, 1 to 3 percent slopes, eroded.	9	IIe–1, Dryland or Irrigated	15	Silty	22
HKB	Holdrege and Keith silt loams, 3 to 6 percent slopes.	9	IIIe–1, Dryland or Irrigated	17	Silty	22
HKB2	Holdrege and Keith silt loams, 3 to 6 percent slopes, eroded.	9	IIIe–1, Dryland or Irrigated	17	Silty	22
HSs	Hord-slickspot complex	10	IVs–1, Dryland; IIIs–1, Irrigated.	19	Silty	22
Lt	Las loam	11	IIw–4, Dryland or Irrigated	16	Subirrigated	22
2Lt	Las loam, saline-alkali	11	IVs–1, Dryland; IIIs–1, Irrigated.	19	Saline Subirrigated.	22
2Lz	Las sand, overwash	11	IVw–5, Dryland; IIIw–5, Irrigated.	18	Subirrigated	22
2Mg	McCook loam, overflow	12	IIw–3, Dryland or Irrigated	16	Overflow	22
MH	McCook and Haverson loams	12	I–1, Dryland or Irrigated	15	Silty	22
Sx	Sandy alluvial land	12	VIw–5, Dryland	19	Subirrigated	22
Sy	Broken alluvial land	7	VIw–1, Dryland	19	Overflow	22
UsB2	Ulysses silt loam, 3 to 6 percent slopes, eroded.	13	IIIe–1, Dryland or Irrigated	17	Thin Silty	23
UsC	Ulysses silt loam, 6 to 9 percent slopes	13	IVe–1, Dryland or Irrigated	18	Silty	22
UsC2	Ulysses silt loam, 6 to 9 percent slopes, eroded.	13	IVe–1, Dryland or Irrigated	18	Thin Silty	23

Accessibility Statement

This document is not accessible by screen-reader software. The Natural Resources Conservation Service (NRCS) is committed to making its information accessible to all of its customers and employees. If you are experiencing accessibility issues and need assistance, please contact our Helpdesk by phone at (800) 457-3642 or by e-mail at ServiceDesk-FTC@ftc.usda.gov. For assistance with publications that include maps, graphs, or similar forms of information, you may also wish to contact our State or local office. You can locate the correct office and phone number at http://offices.sc.egov.usda.gov/locator/app.

Nondiscrimination Statement

Nondiscrimination Policy

The U.S. Department of Agriculture (USDA) prohibits discrimination against its customers, employees, and applicants for employment on the basis of race, color, national origin, age, disability, sex, gender identity, religion, reprisal, and where applicable, political beliefs, marital status, familial or parental status, sexual orientation, whether all or part of an individual's income is derived from any public assistance program, or protected genetic information. The Department prohibits discrimination in employment or in any program or activity conducted or funded by the Department. (Not all prohibited bases apply to all programs and/or employment activities.)

To File an Employment Complaint

If you wish to file an employment complaint, you must contact your agency's EEO Counselor (http://directives.sc.egov.usda.gov/33081.wba) within 45 days of the date of the alleged discriminatory act, event, or personnel action. Additional information can be found online at http://www.ascr.usda.gov/complaint_filing_file.html.

To File a Program Complaint

If you wish to file a Civil Rights program complaint of discrimination, complete the USDA Program Discrimination Complaint Form, found online at http://www.ascr.usda.gov/complaint_filing_cust.html or at any USDA office, or call (866) 632-9992 to request the form. You may also write a letter containing all of the information requested in the form. Send your completed complaint form or letter by mail to U.S. Department of Agriculture; Director, Office of Adjudication; 1400 Independence Avenue, S.W.; Washington, D.C. 20250-9419; by fax to (202) 690-7442; or by email to program.intake@usda.gov.

Persons with Disabilities

If you are deaf, are hard of hearing, or have speech disabilities and you wish to file either an EEO or program complaint, please contact USDA through the Federal Relay Service at (800) 877-8339 or (800) 845-6136 (in Spanish).

If you have other disabilities and wish to file a program complaint, please see the contact information above. If you require alternative means of communication for

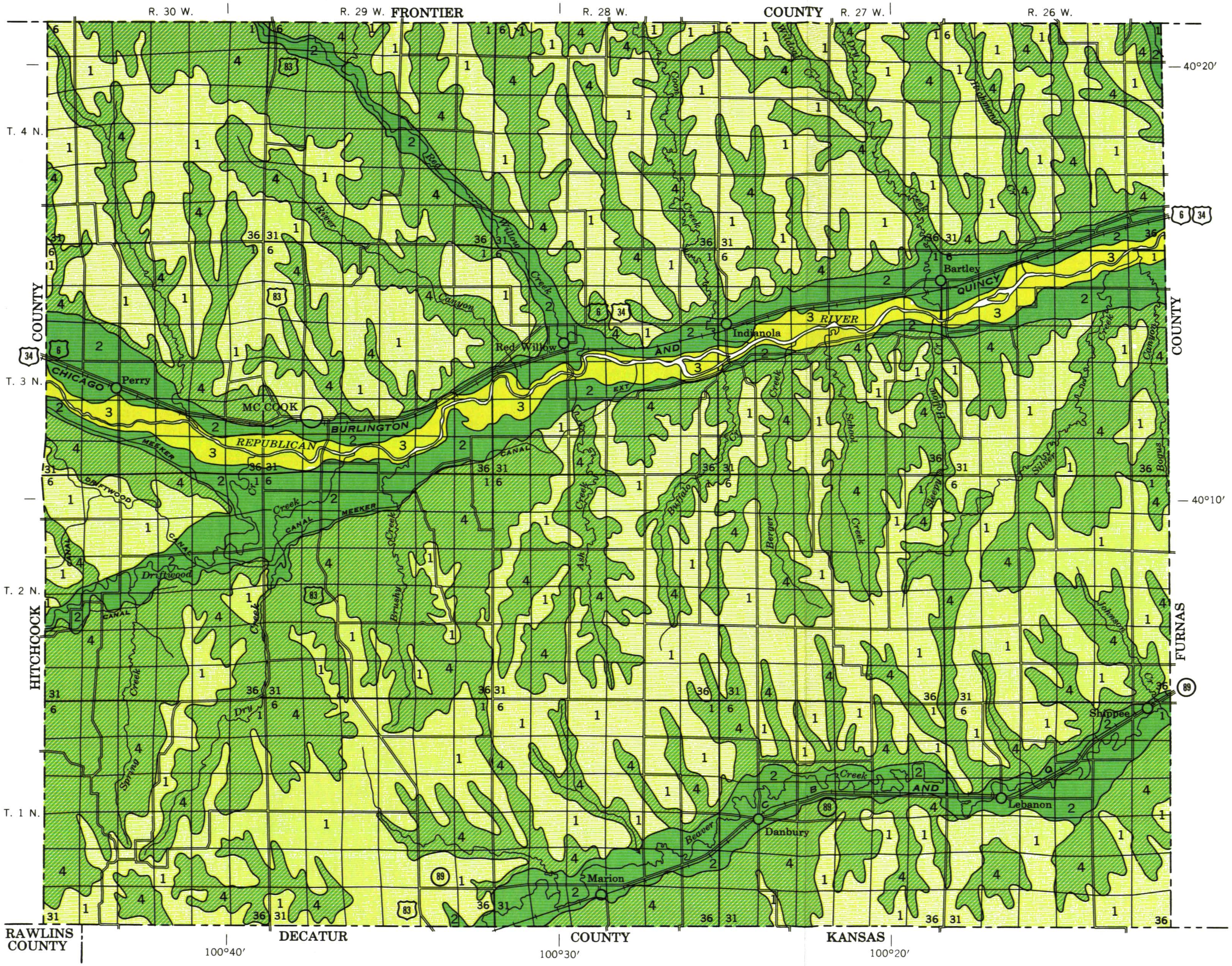
program information (e.g., Braille, large print, audiotape, etc.), please contact USDA's TARGET Center at (202) 720-2600 (voice and TDD).

Supplemental Nutrition Assistance Program

For additional information dealing with Supplemental Nutrition Assistance Program (SNAP) issues, call either the USDA SNAP Hotline Number at (800) 221-5689, which is also in Spanish, or the State Information/Hotline Numbers (http://directives.sc.egov.usda.gov/33085.wba).

All Other Inquiries

For information not pertaining to civil rights, please refer to the listing of the USDA Agencies and Offices (http://directives.sc.egov.usda.gov/33086.wba).



N

SOIL ASSOCIATIONS

1 — Holdrege-Keith association: Silty soils on nearly level to moderately sloping loess uplands and in sloping to steep canyons

2 — Hord, terrace-McCook-Bridgeport association: Loamy soils on stream terraces, bottom lands, and foot slopes

3 — Sandy alluvial land-Las-Glenberg association: Sandy and loamy soils on lowlands along the Republican River

4 — Colby association: Silty soils on the steep loess hills and in canyons

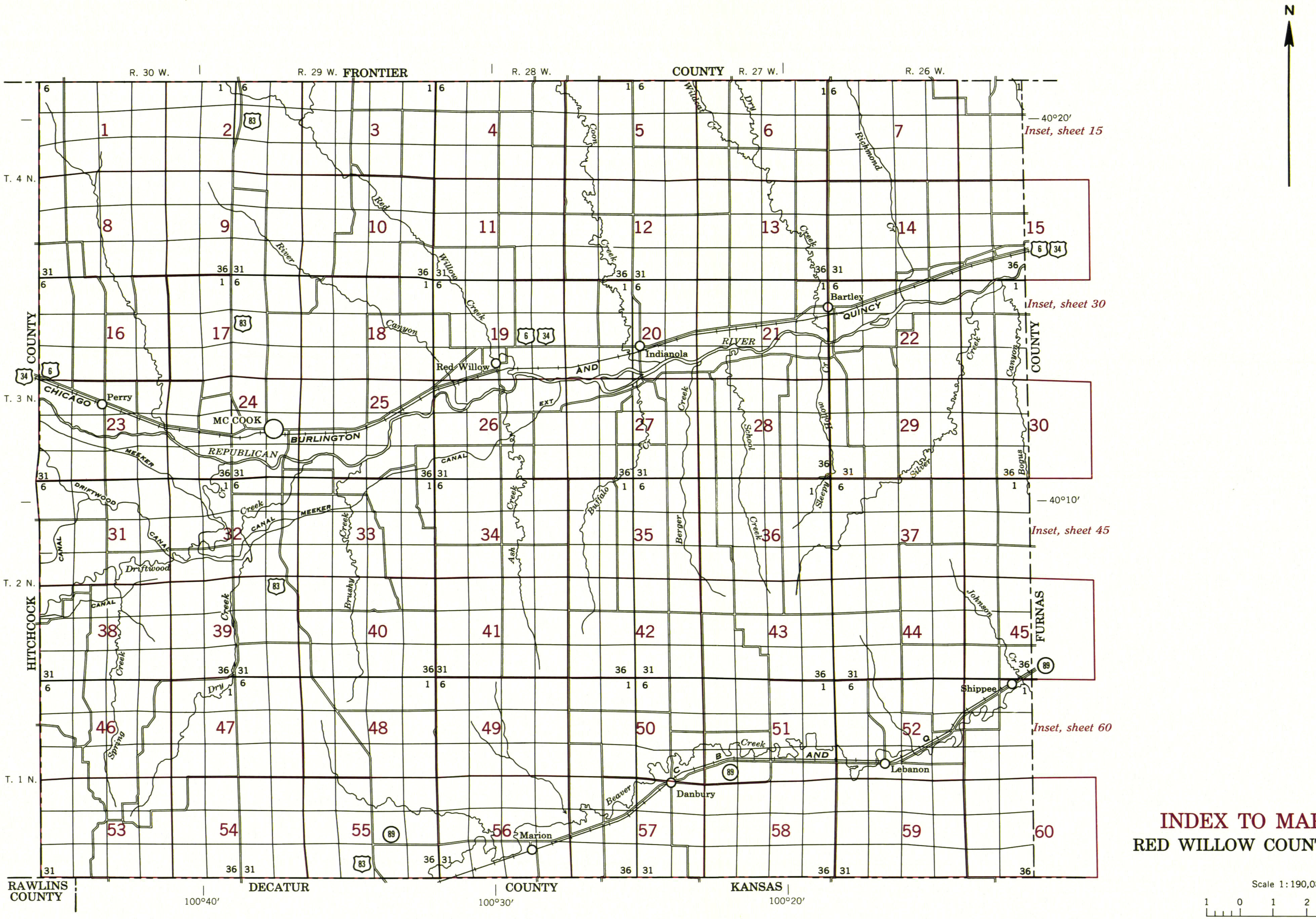
April 1966

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
UNIVERSITY OF NEBRASKA
CONSERVATION AND SURVEY DIVISION

GENERAL SOIL MAP
RED WILLOW COUNTY, NEBRASKA

Scale 1:190,080

1 0 1 2 3 4 Miles



INDEX TO MAP SHEETS
RED WILLOW COUNTY, NEBRASKA

Scale 1 : 190,080

1 0 1 2 3 4 Miles

CONVENTIONAL SIGNS

WORKS AND STRUCTURES

Highways and roads
- Dual
- Good motor
- Poor motor
- Trail

Highway markers
- National Interstate
- U. S.
- State

Railroads
- Single track
- Multiple track
- Abandoned

Bridges and crossings
- Road
- Trail, foot
- Railroad
- Ferries
- Ford
- Grade
- R. R. over
- R. R. under
- Tunnel

Buildings
- School
- Church

Windmill

Mines and Quarries

Mine dump

Pits, gravel or other

Power lines

Pipe lines

Cemeteries

Dams

Levees

Tank, oil or gas

Oil or gas well

BOUNDARIES

- National or state
- County
- Township, U. S.
- Section line, corner
- Reservation
- Land grant

DRAINAGE

Streams
- Perennial
- Intermittent, unclass.

Canals and ditches (CANAL / DITCH)

Lakes and ponds
- Perennial
- Intermittent

Well, irrigation

Springs

Marsh

Wet spot

Alluvial fan

Drainage end

RELIEF

Escarpments
- Bedrock
- Other

Prominent peaks

Depression, unclassified

SOIL SURVEY DATA

- Soil boundary and symbol (Dx)
- Gravel
- Stones
- Rock outcrops
- Chert fragments
- Clay spot
- Sand spot
- Alkali spot
- Made land
- Severely eroded spot
- Blowout, wind erosion
- Gullies
- Short slope or terraced soil

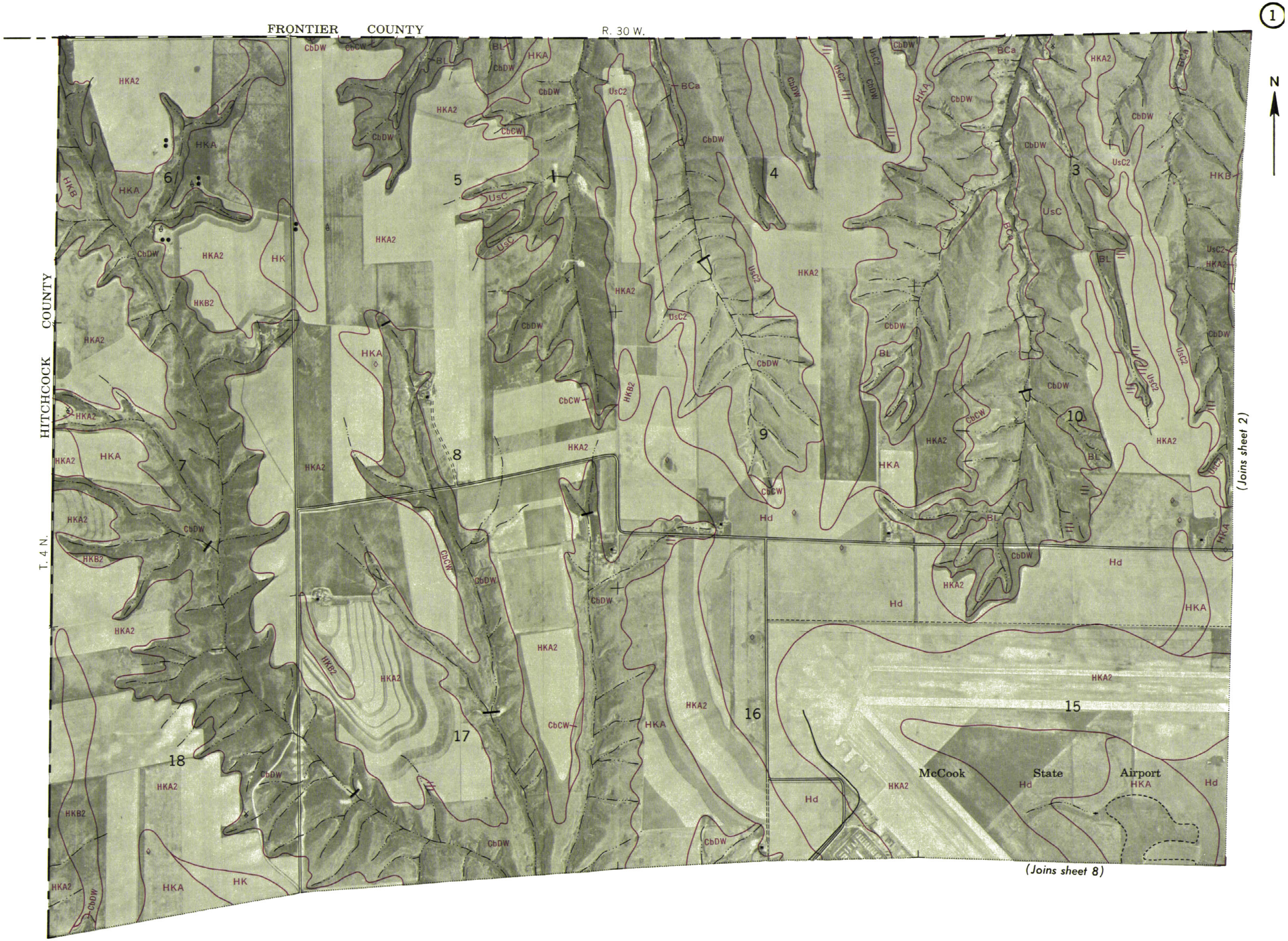
SOIL LEGEND

Each soil symbol consists of letters or of letters and numbers; for example, HKA, HKA2, Hd, 2Hd, 2HdA. The last capital letter shows the slope if slope forms part of the soil name. A final number, 2, shows that the soil is eroded. A final capital letter, W, indicates evidence of erosion that has not modified the soil enough to be estimated with reliability.

SYMBOL	NAME
Bb	Bankard fine sand
Bc	Bankard loamy fine sand
BCa	Rough broken land, caliche
Bf	Bayard fine sandy loam, 0 to 1 percent slopes
BfA	Bayard fine sandy loam, 1 to 3 percent slopes
2Bk	Bayard loam, slightly wet
BL	Rough broken land, loess
Bn	Barney silty clay loam
Br	Bridgeport silt loam, 0 to 1 percent slopes
BrA	Bridgeport silt loam, 1 to 3 percent slopes
BrB	Bridgeport silt loam, 3 to 6 percent slopes
CbCW	Colby silt loam, 3 to 9 percent slopes
CbDW	Colby silt loam, 9 to 30 percent slopes
Gd	Glenberg fine sandy loam
2Gd	Glenberg fine sandy loam, slightly wet
GK	Glenberg loam
Hd	Hord silt loam, 0 to 1 percent slopes
2Hd	Hord silt loam, terrace, 0 to 1 percent slopes
2HdA	Hord silt loam, terrace, 1 to 3 percent slopes
Hf	Haverson fine sandy loam
HK	Holdrege and Keith silt loams, 0 to 1 percent slopes
HKA	Holdrege and Keith silt loams, 1 to 3 percent slopes
HKA2	Holdrege and Keith silt loams, 1 to 3 percent slopes, eroded
HKB	Holdrege and Keith silt loams, 3 to 6 percent slopes
HKB2	Holdrege and Keith silt loams, 3 to 6 percent slopes, eroded
HSs	Hord–slickspot complex
Lt	Las loam
2Lt	Las loam, saline–alkali
2Lz	Las sand, overwash
2Mg	McCook loam, overflow
MH	McCook and Haverson loams
Sx	Sandy alluvial land
Sy	Broken alluvial land
UsB2	Ulysses silt loam, 3 to 6 percent slopes, eroded
UsC	Ulysses silt loam, 6 to 9 percent slopes
UsC2	Ulysses silt loam, 6 to 9 percent slopes, eroded

Soil map constructed 1966 by Cartographic Division, Soil Conservation Service, USDA, from 1958 aerial photographs. Controlled mosaic based on Nebraska plane coordinate system, south zone, Lambert conformal conic projection, 1927 North American datum.

RED WILLOW COUNTY, NEBRASKA — SHEET NUMBER 1



This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of Nebraska, Conservation and Survey Division.

Range, township, and section corners shown on this map are indefinite.

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

RED WILLOW COUNTY, NEBRASKA — SHEET NUMBER 2

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of Nebraska, Conservation and Survey Division.

Range, township, and section corners shown on this map are indefinite.

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

4

RED WILLOW COUNTY, NEBRASKA — SHEET NUMBER 4

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

0 ½ 1 Mile
Scale 1:20000
0 5000 Feet

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of Nebraska, Conservation and Survey Division.

Range, township, and section corners shown on this map are indefinite.

RED WILLOW COUNTY, NEBRASKA — SHEET NUMBER 6

RED WILLOW COUNTY, NEBRASKA — SHEET NUMBER 7

7

(Joins sheet 6)

(Joins inset, sheet 15)

(Joins sheet 14)

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of Nebraska, Conservation and Survey Division.

Range, township, and section corners shown on this map are indefinite.

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

RED WILLOW COUNTY, NEBRASKA — SHEET NUMBER 8

0 ½ 1 Mile
Scale 1:20000
0 5000 Feet

RED WILLOW COUNTY, NEBRASKA — SHEET NUMBER 9

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of Nebraska, Conservation and Survey Division.

Range, township, and section corners shown on this map are indefinite.

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

(10)


(Joins sheet 3)
R. 29 W.
N
(Joins sheet 9)
(Joins sheet 11)
(Joins sheet 18)
T. 4 N.
21
22
23
24
25
26
27
28
33
34
35
36
Red Willow Creek
River
0
½
1 Mile
Scale 1:20000
0
5000 Feet

11

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of Nebraska, Conservation and Survey Division.

Range, township, and section corners shown on this map are indefinite.

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

RED WILLOW COUNTY, NEBRASKA — SHEET NUMBER 12

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

0 ½ 1 Mile
Scale 1:20000
0 5000 Feet

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of Nebraska, Conservation and Survey Division.

Range, township, and section corners shown on this map are indefinite.

RED WILLOW COUNTY, NEBRASKA — SHEET NUMBER 14

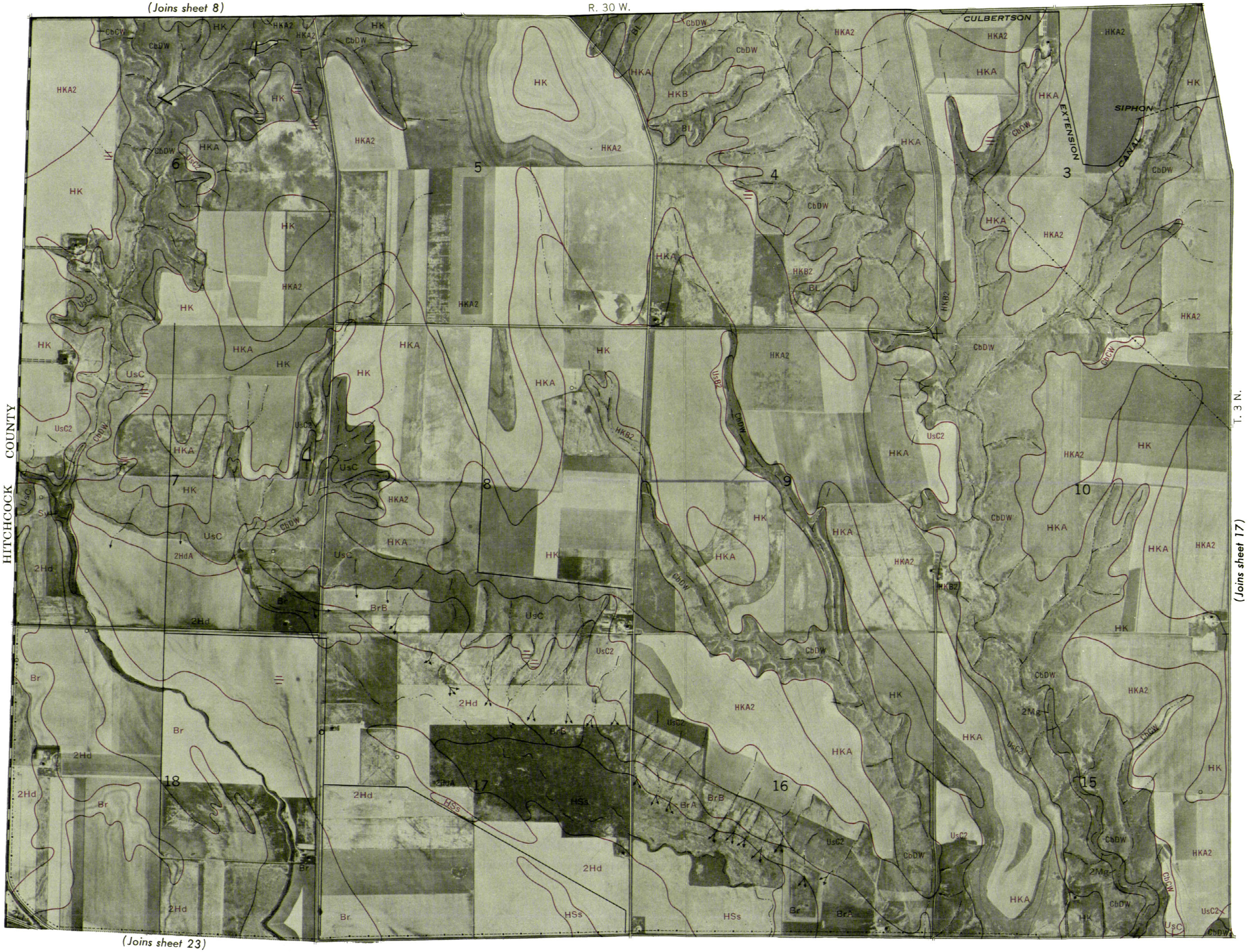
This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of Nebraska, Conservation and Survey Division.

Range, township, and section corners shown on this map are indefinite.

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet



0 ½ 1 Mile Scale 1:20000 0 5000 Feet

RED WILLOW COUNTY, NEBRASKA — SHEET NUMBER 17

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of Nebraska, Conservation and Survey Division.

Range, township, and section corners shown on this map are indefinite.

17

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

RED WILLOW COUNTY, NEBRASKA — SHEET NUMBER 18

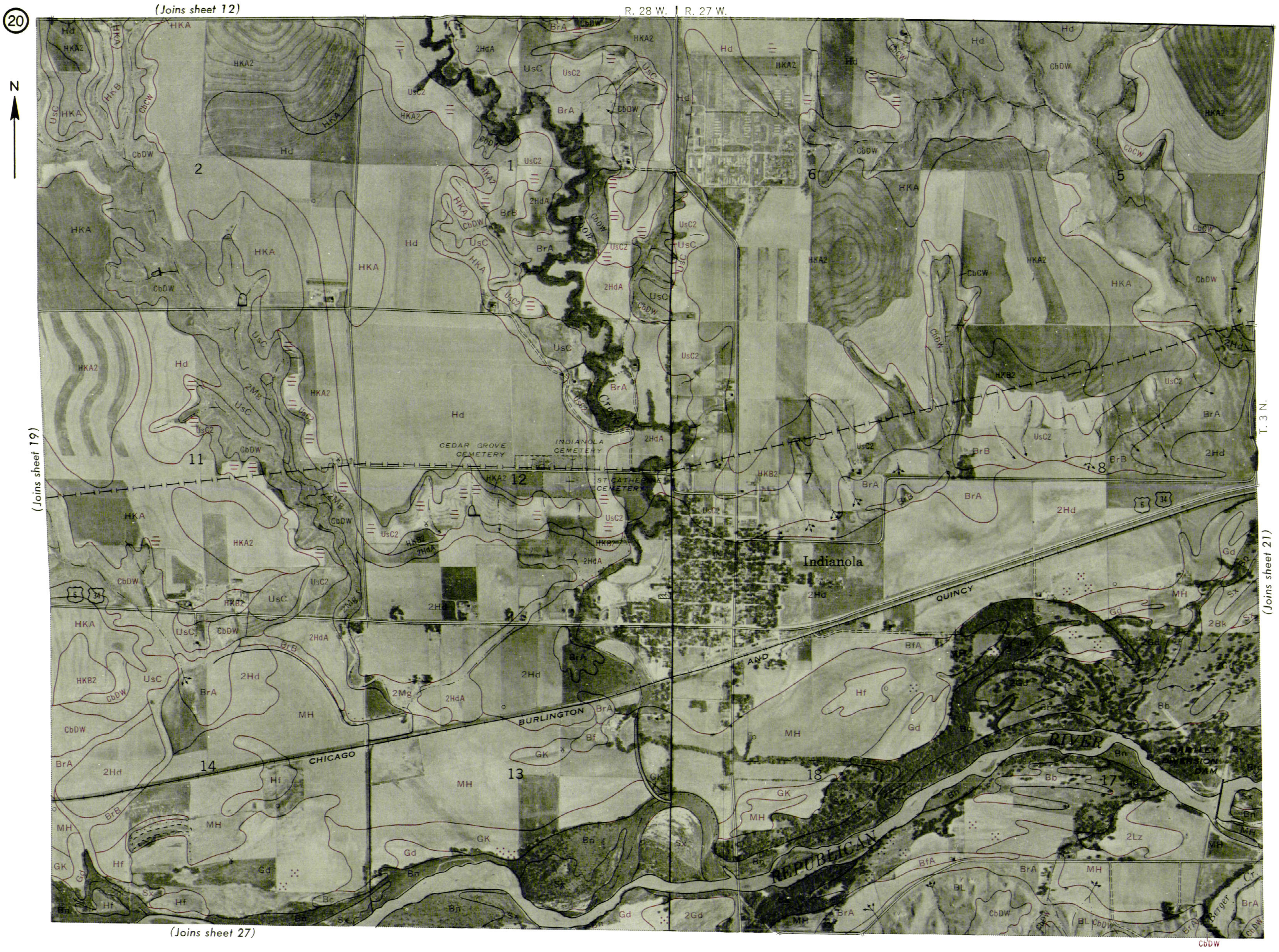
RED WILLOW COUNTY, NEBRASKA — SHEET NUMBER 19

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of Nebraska, Conservation and Survey Division.

Range, township, and section corners shown on this map are indefinite.

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

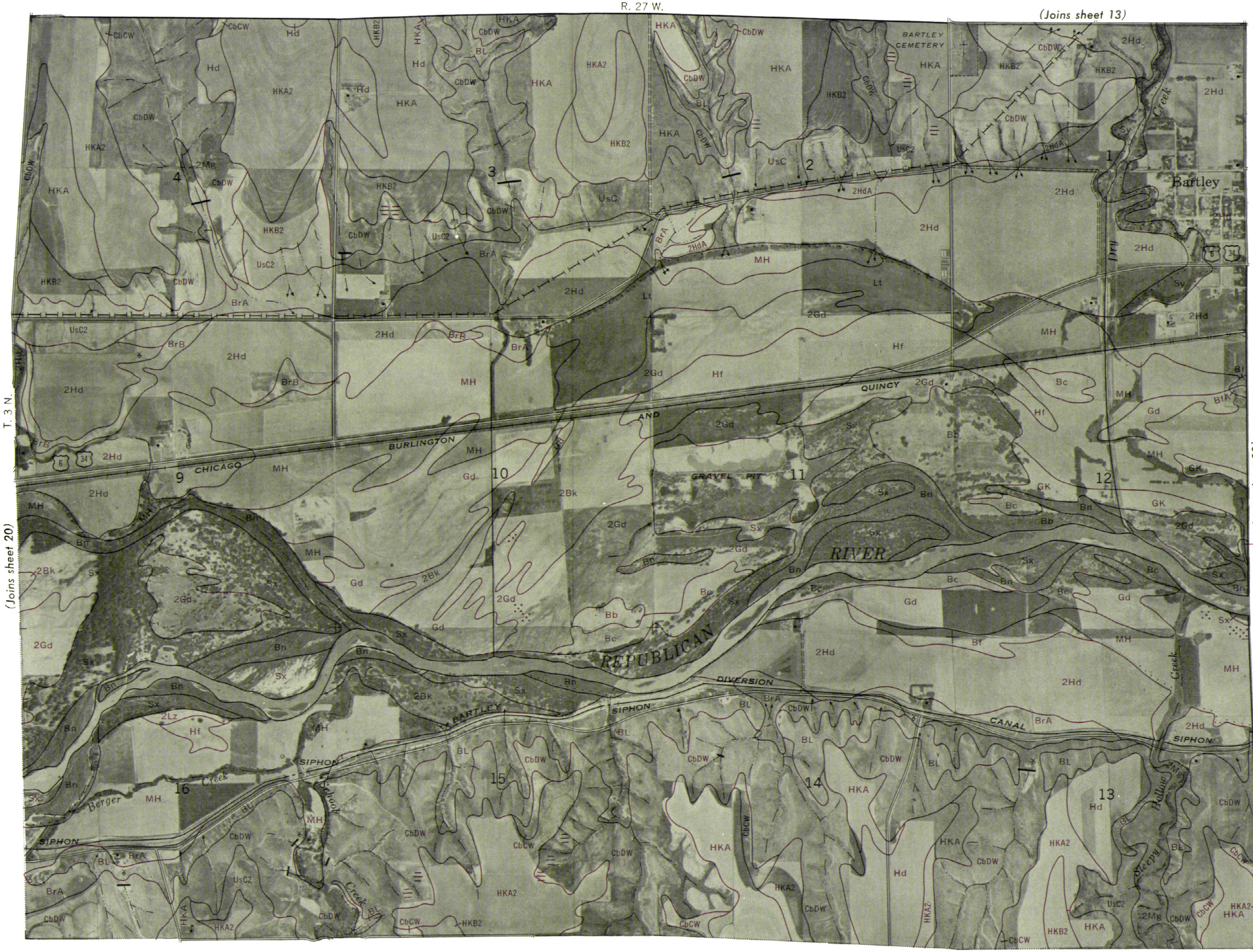
RED WILLOW COUNTY, NEBRASKA — SHEET NUMBER 20



0 ½ 1 Mile Scale 1:20000 0 5000 Feet

RED WILLOW COUNTY, NEBRASKA — SHEET NUMBER 21

21



0 ½ 1 Mile Scale 1:20000 0 5000 Feet

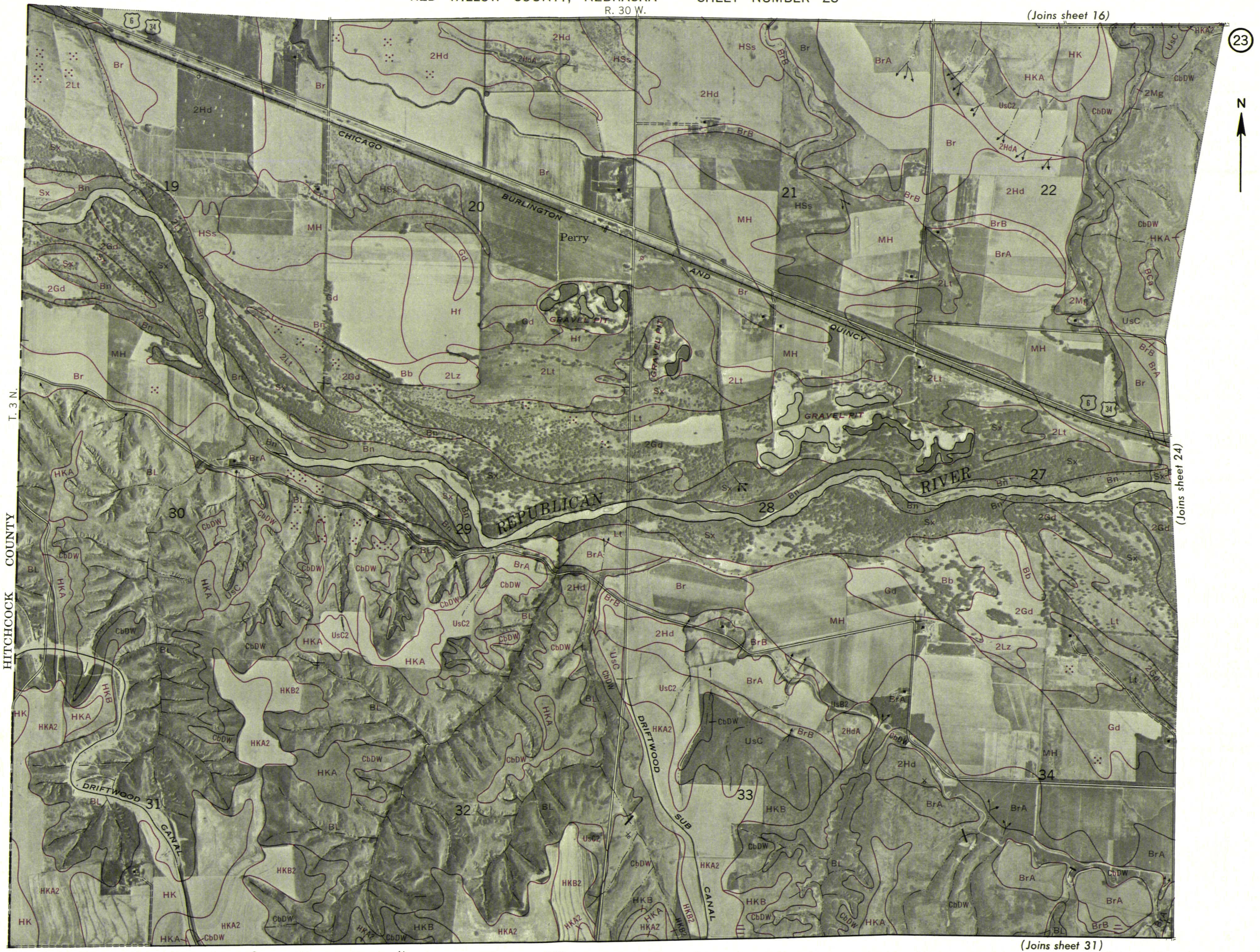
This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of Nebraska, Conservation and Survey Division.

Range, township, and section corners shown on this map are indefinite.

RED WILLOW COUNTY, NEBRASKA — SHEET NUMBER 22

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

RED WILLOW COUNTY, NEBRASKA — SHEET NUMBER 23

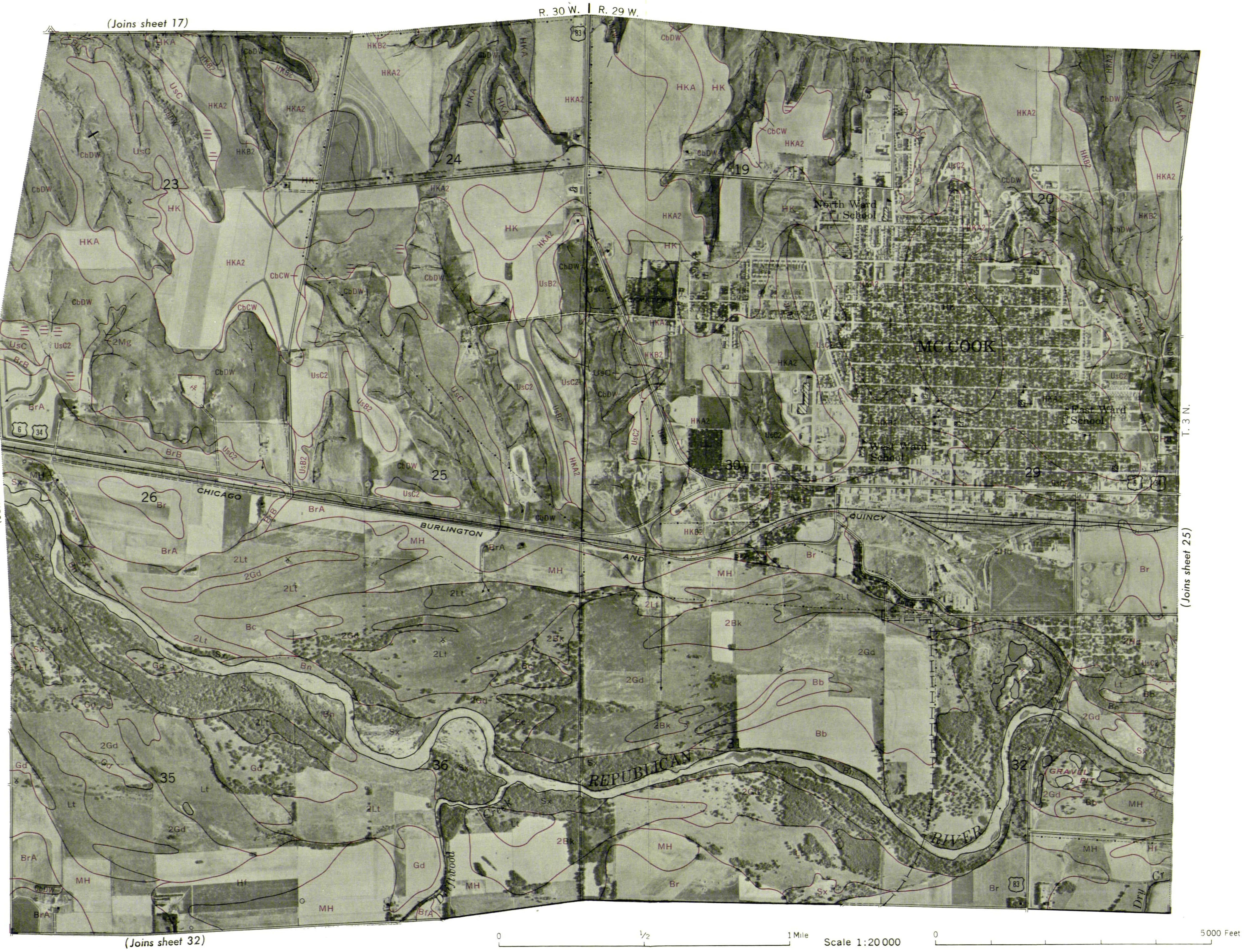


0 ½ 1 Mile Scale 1:20000 0 5000 Feet

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of Nebraska, Conservation and Survey Division.

Range, township, and section corners shown on this map are indefinite

RED WILLOW COUNTY, NEBRASKA — SHEET NUMBER 24



25

N

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of Nebraska, Conservation and Survey Division.

Range, township, and section corners shown on this map are indefinite.

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

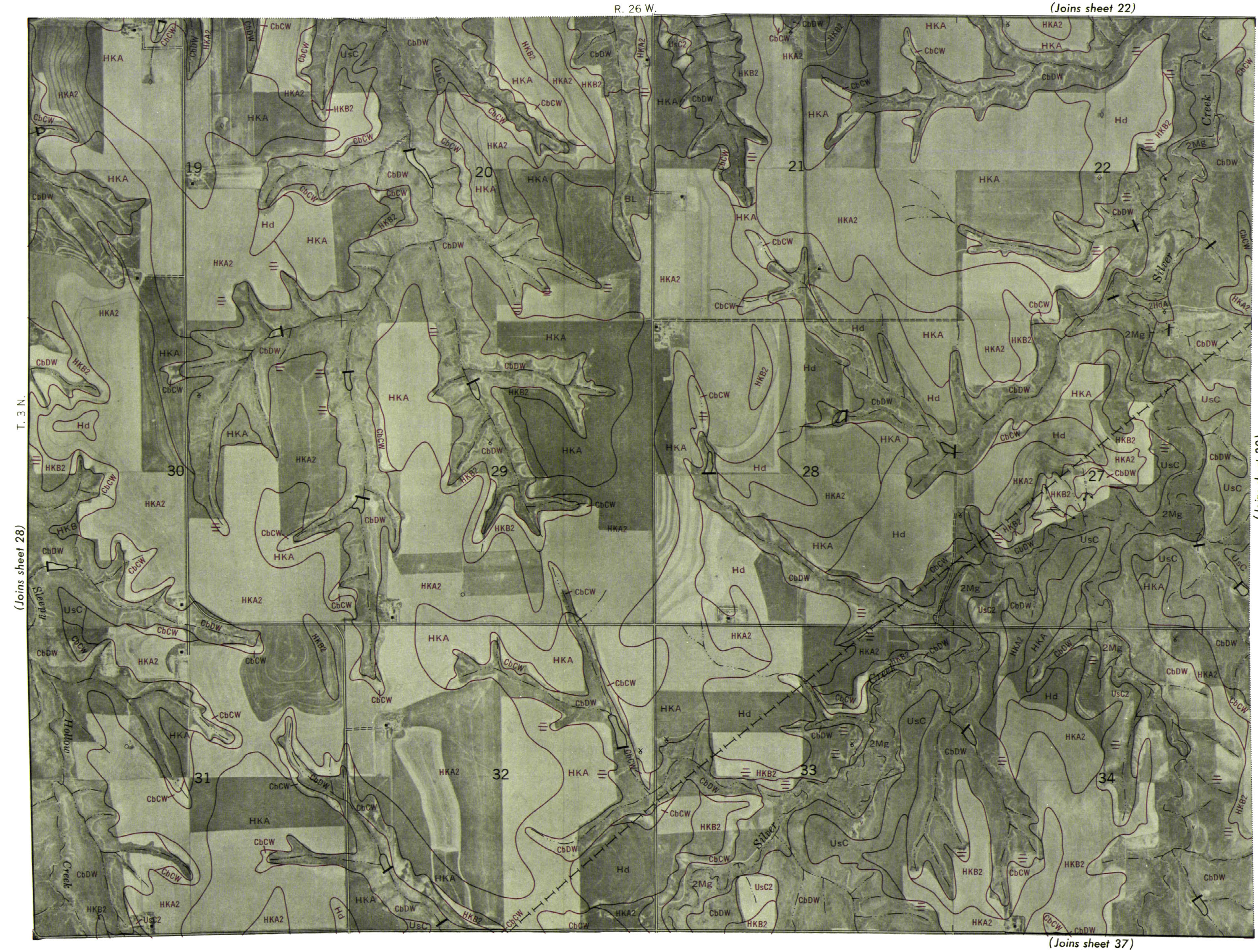
This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of Nebraska, Conservation and Survey Division.

Range, township, and section corners shown on this map are indefinite.

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

RED WILLOW COUNTY, NEBRASKA — SHEET NUMBER 28

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

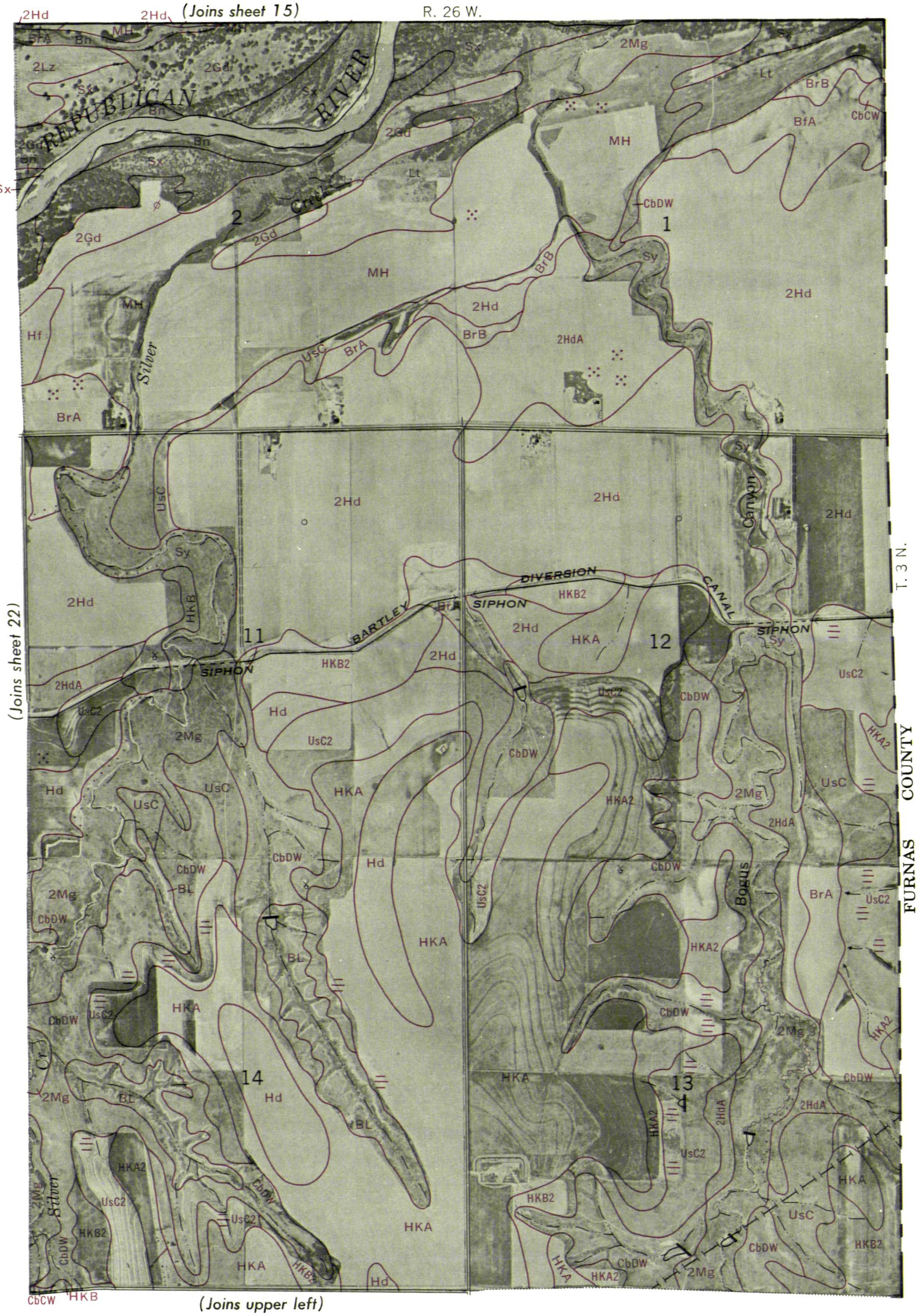


This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of Nebraska, Conservation and Survey Division.

Range, township, and section corners shown on this map are indefinite

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

RED WILLOW COUNTY, NEBRASKA — SHEET NUMBER 30



0 ½ 1 Mile Scale 1:20000 0 5000 Feet

RED WILLOW COUNTY, NEBRASKA — SHEET NUMBER 31

(Joins sheet 23)

31

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of Nebraska, Conservation and Survey Division.

Range, township, and section corners shown on this map are indefinite.

5000 Feet

0

Scale 1:20000

1 Mile

½

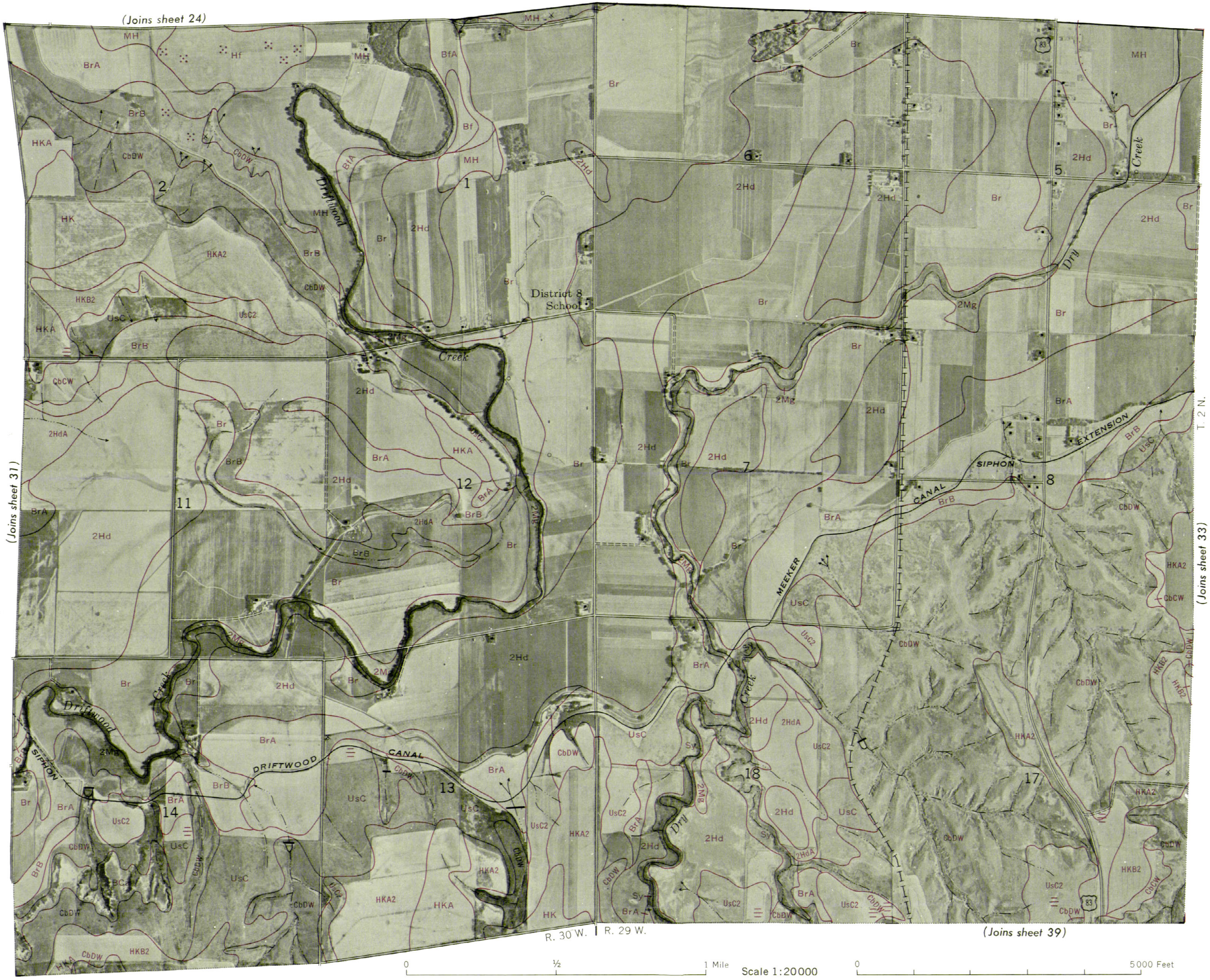
0

(Joins sheet 32)

(Joins sheet 38)

R. 30 W.

RED WILLOW COUNTY, NEBRASKA — SHEET NUMBER 32



33

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of Nebraska, Conservation and Survey Division.

Range, township, and section corners shown on this map are indefinite.

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

RED WILLOW COUNTY, NEBRASKA — SHEET NUMBER 34

(34)

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

35

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of Nebraska, Conservation and Survey Division.

Range, township, and section corners shown on this map are indefinite.

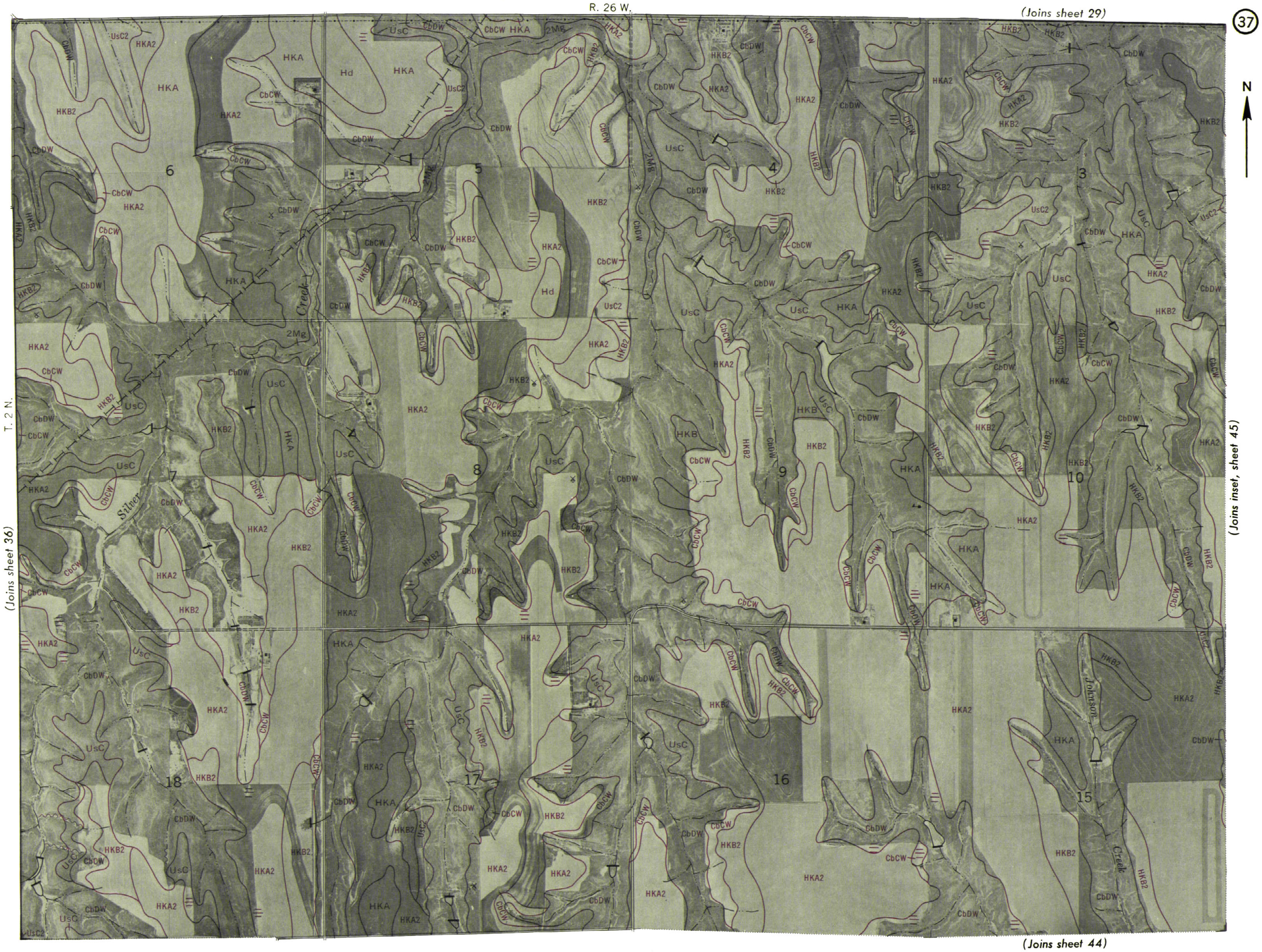
RED WILLOW COUNTY, NEBRASKA — SHEET NUMBER 36

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

RED WILLOW COUNTY, NEBRASKA — SHEET NUMBER 37

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of Nebraska, Conservation and Survey Division.

Range, township, and section corners shown on this map are indefinite.



0 ½ 1 Mile Scale 1:20000 0 5000 Feet

38

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

RED WILLOW COUNTY, NEBRASKA — SHEET NUMBER 39

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of Nebraska, Conservation and Survey Division.

Range, township, and section corners shown on this map are indefinite.

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

40

(Joins sheet 33)

(Joins sheet 48)

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

41

R. 28 W.

(Joins sheet 34)

T. 2 N.

(Joins sheet 40)

(Joins sheet 42)

(Joins sheet 49)

0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

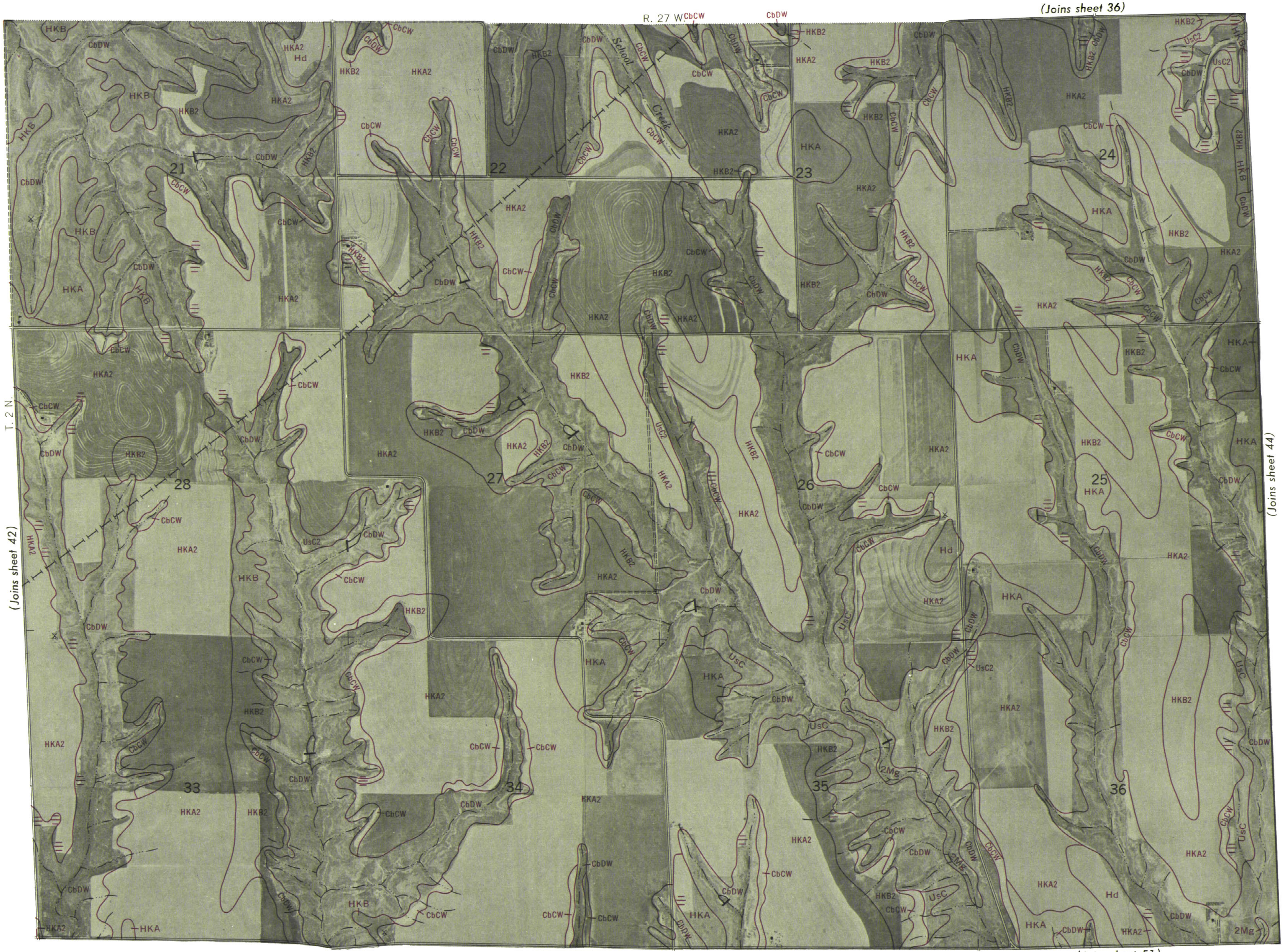
N

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of Nebraska, Conservation and Survey Division.

Range, township, and section corners shown on this map are indefinite.

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

43



0 ½ 1 Mile Scale 1:20000 0 5000 Feet

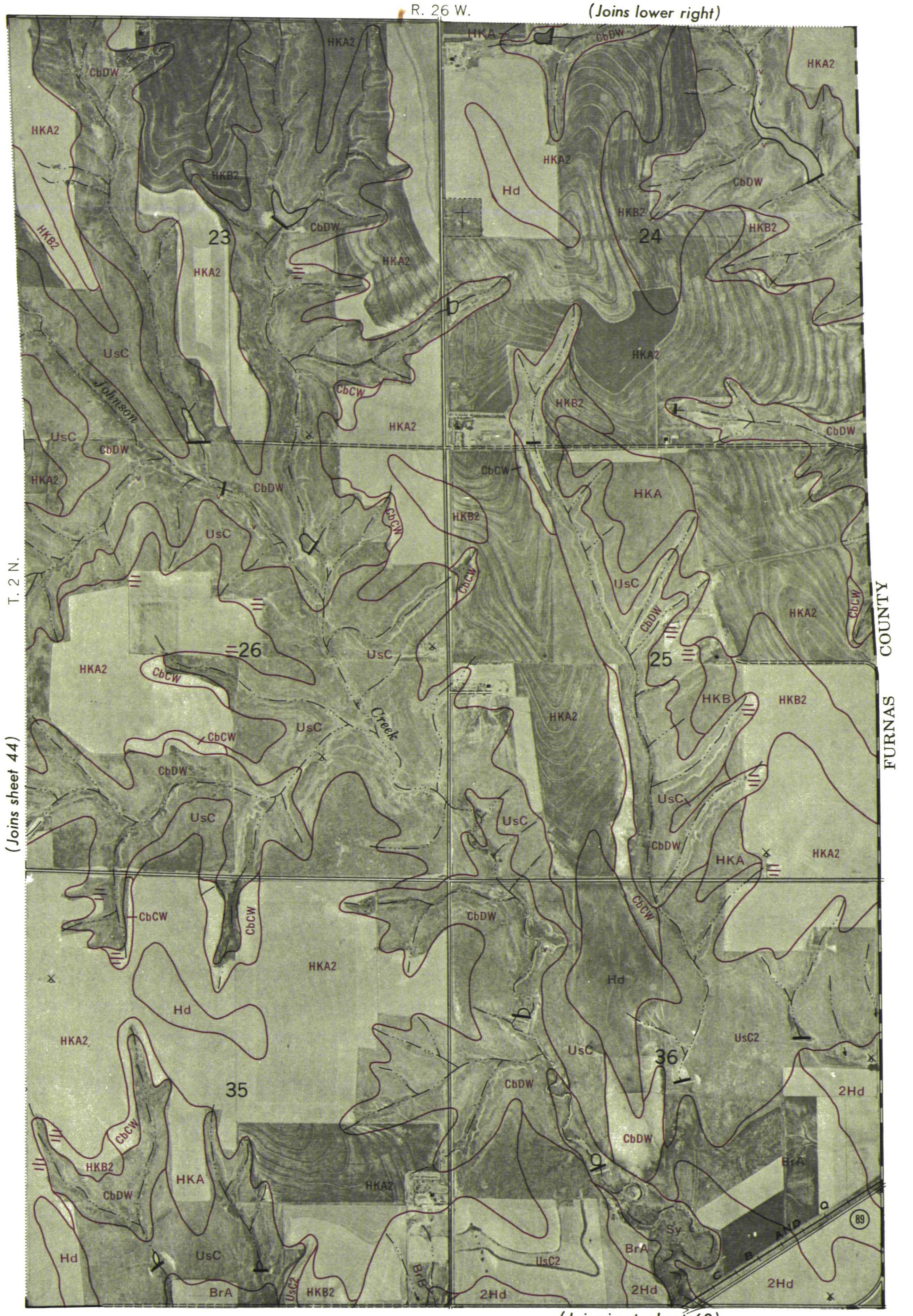
This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of Nebraska, Conservation and Survey Division.

Range, township, and section corners shown on this map are indefinite.

RED WILLOW COUNTY, NEBRASKA — SHEET NUMBER 44

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of Nebraska, Conservation and Survey Division.

Range, township, and section corners shown on this map are indefinite.



0 ½ 1 Mile

Scale 1:20000

0 5000 Feet

RED WILLOW COUNTY, NEBRASKA — SHEET NUMBER 46

RED WILLOW COUNTY, NEBRASKA — SHEET NUMBER 47

47

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of Nebraska, Conservation and Survey Division.

Range, township, and section corners shown on this map are indefinite.

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

RED WILLOW COUNTY, NEBRASKA — SHEET NUMBER 48

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

RED WILLOW COUNTY, NEBRASKA — SHEET NUMBER 49

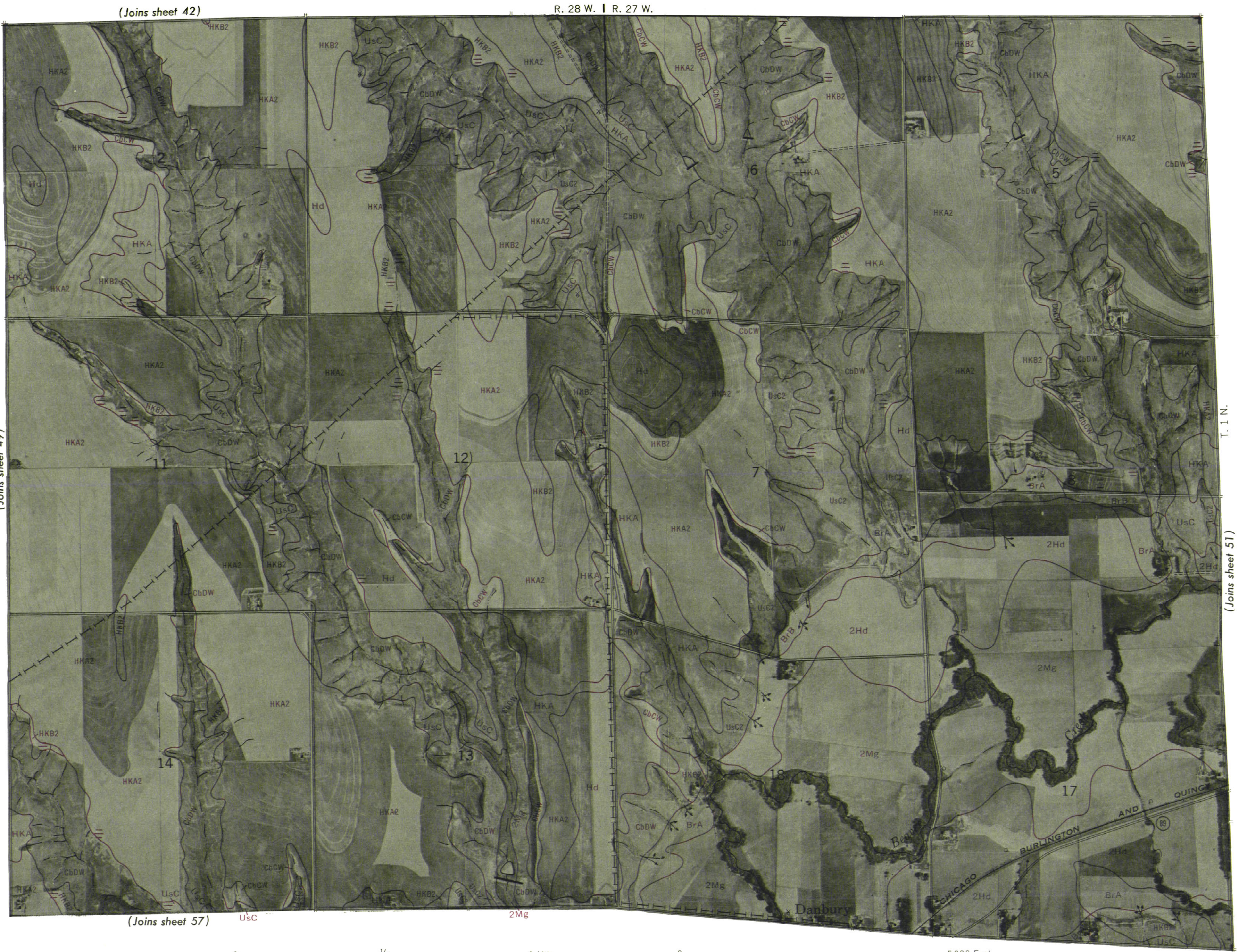
This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of Nebraska, Conservation and Survey Division.

Range, township, and section corners shown on this map are indefinite.

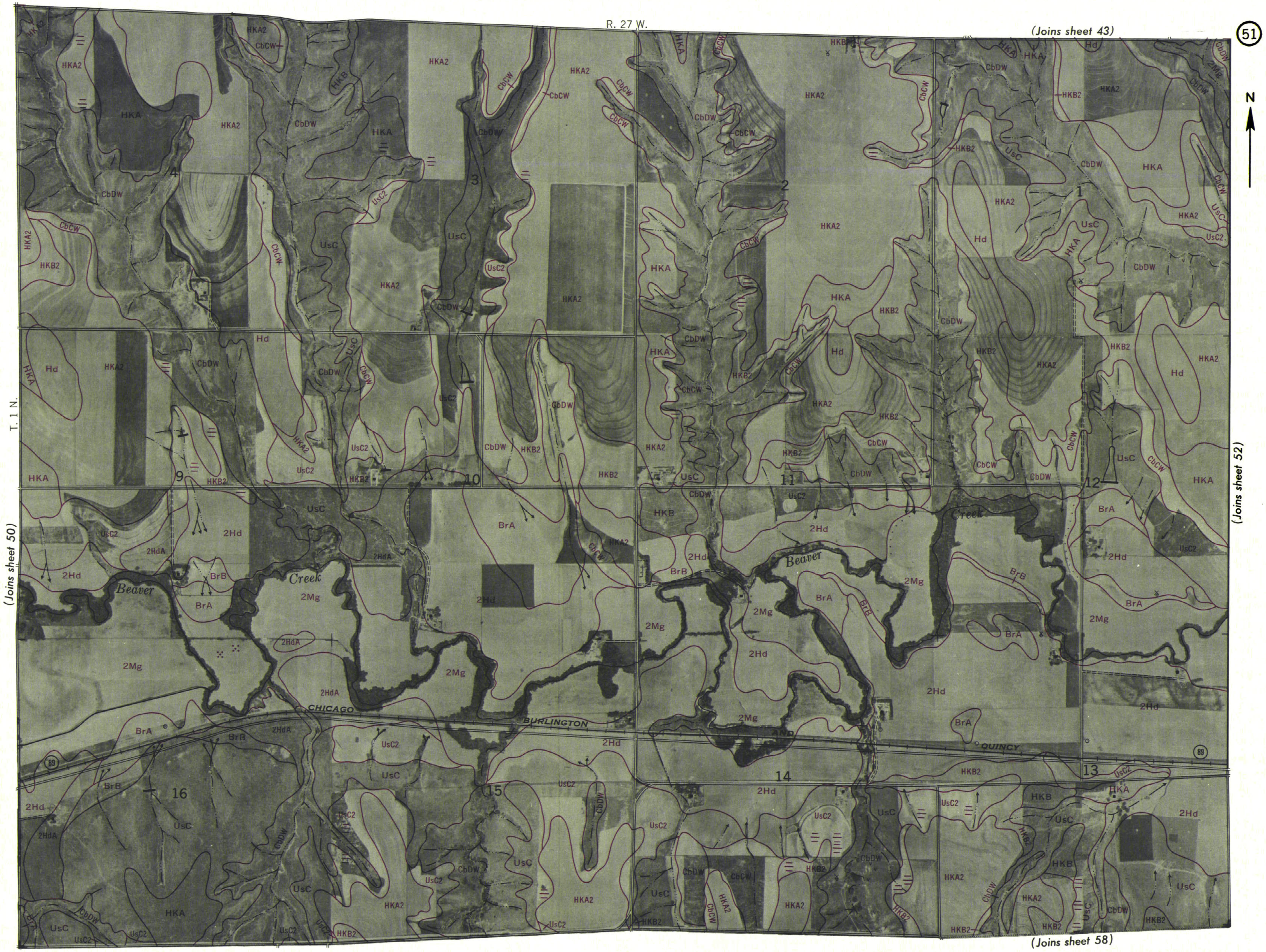
(Joins sheet 41)

(Joins sheet 56)

0 ½ 1 Mile Scale 1:20000 0 5000 Feet



0 ½ 1 Mile Scale 1:20000 0 5000 Feet



0 ½ 1 Mile Scale 1:20000 0 5000 Feet

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of Nebraska, Conservation and Survey Division.

Range, township, and section corners shown on this map are indefinite.

RED WILLOW COUNTY, NEBRASKA — SHEET NUMBER 52

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of Nebraska, Conservation and Survey Division.

Range, township, and section corners shown on this map are indefinite.

Scale 1:20000

0 ½ 1 Mile

0 5000 Feet

RED WILLOW COUNTY, NEBRASKA — SHEET NUMBER 54

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of Nebraska, Conservation and Survey Division.

Range, township, and section corners shown on this map are indefinite.

RED WILLOW COUNTY, NEBRASKA — SHEET NUMBER 56

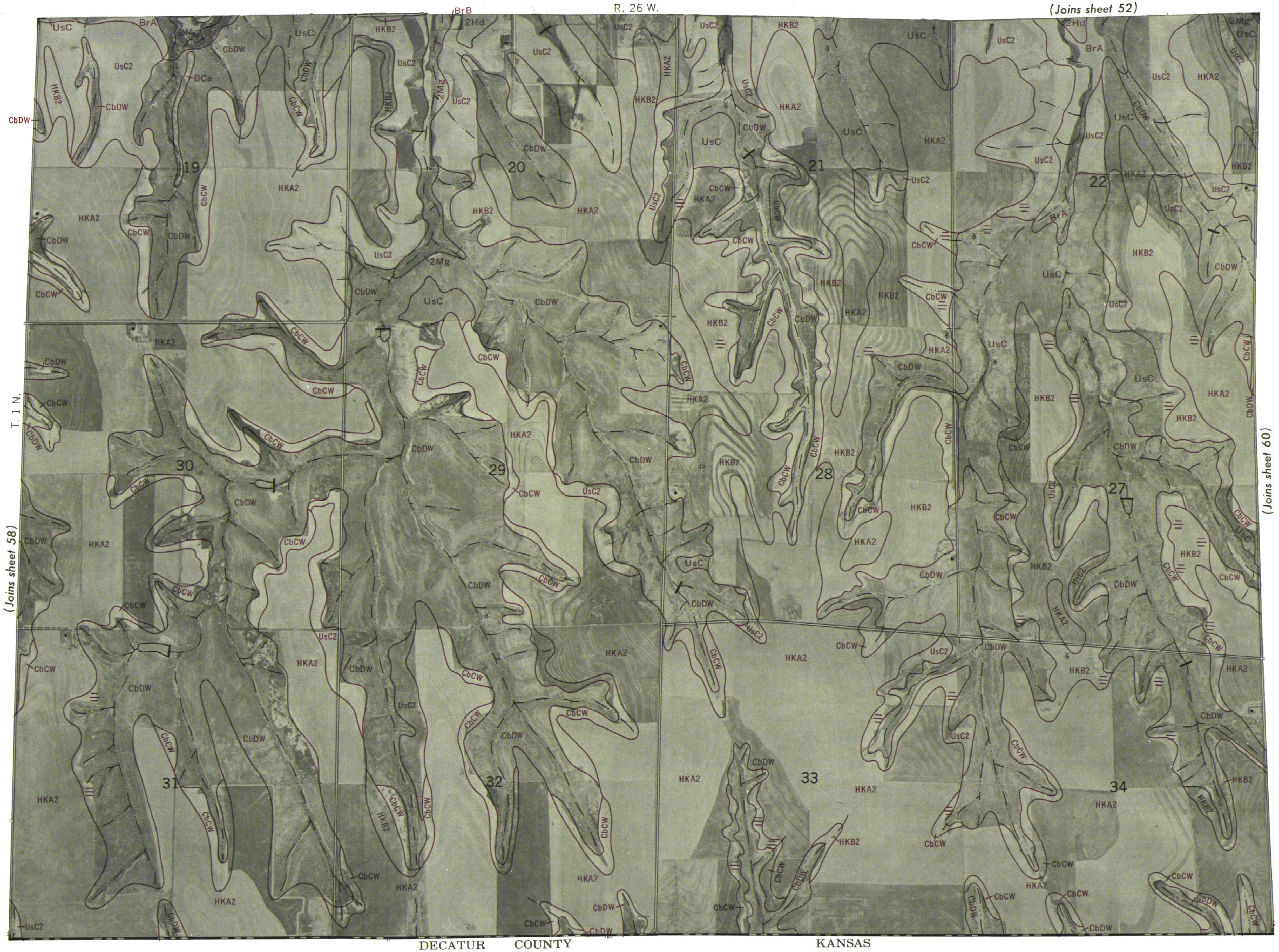
0 ½ 1 Mile Scale 1:20000 0 5000 Feet

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of Nebraska, Conservation and Survey Division.

Range, township, and section corners shown on this map are indefinite.

58

0 ½ 1 Mile Scale 1:20000 0 5000 Feet



0 ½ 1 Mile Scale 1:20000 0 5000 Feet

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of Nebraska, Conservation and Survey Division.

Range, township, and section corners shown on this map are indefinite.

N

0 ½ 1 Mile Scale 1:20000 0 5000 Feet